General Report on the Operations of the Survey of India Department

administered under the Government of India during 1898-99 to 1900-01

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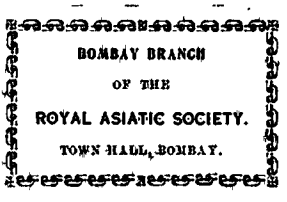

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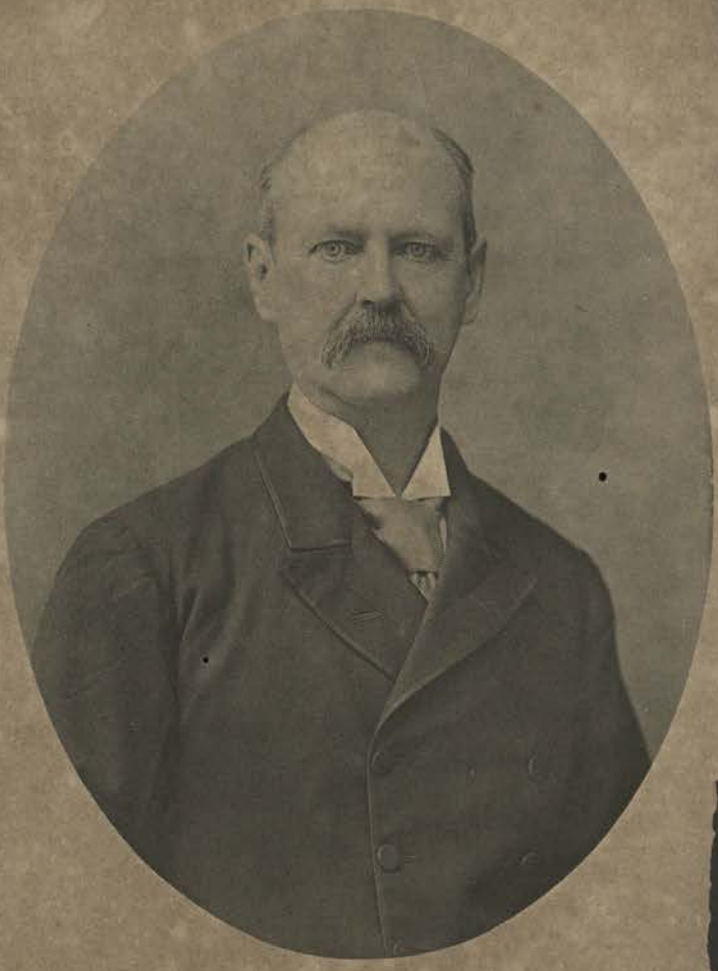

Photogravure. Survey of India Offices, Calcutta, November 1893

Chas Thuhan

From a photograph by Messrs Johnston & Hoffmann

GENERAL REPORT

ON THE

OPERATIONS

OF THE

Survey of India Department.

ADMINISTERED UNDER

THE GOVERNMENT OF INDIA

DURING

1898-99.

PREPARED UNDER THE DIRECTION OF

COLONEL ST. G. C. GORE, R.E.,

SURVEYOR-GENERAL OF INDIA.

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BAY OF BENGAL
INDEX CHART
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OF
INDIA

GENERAL REPORT

ON THE

Operations of the Survey of India

DURING THE SURVEY YEAR

1898-99.

PART I.

SUMMARY.

ADMINISTRATION.

1. The operations of the department that are now reported on are for the survey year ending 30th September 1899.

2. The general administration of the department and the superintendence of the Topographical Branch remained throughout the year in the hands of Major-General C. Strahan, R.E., Surveyor-General of India, who on the 30th September retired from the Department in which he had served for 36 years.

Throughout the year Lieutenant-Colonel J. R. Hobday, I.S.C., Deputy Surveyor-General, held charge of the Revenue Branch.

Major S. G. Burrard, R.E., officiated as Superintendent, Trigonometrical Surveys, until the return of Lieutenant-Colonel St. G. C. Gore, R.E., from special leave on the 31st October, when the latter resumed charge of the Trigonometrical Branch, which he held until the end of the year.

Captain R. T. Crichton, I.S.C., continued to be Superintendent, Settlement Surveys, Bengal, until he proceeded on furlough on the 26th April 1899 when Captain C. W. H. Symonds, I.S.C., was appointed in his place.

Mr. G. B. Scott, the Superintendent of Land Records Surveys in the North-Western Provinces, attained the age of 55 on 31st July 1899, but the Government has been pleased to grant him an extension of service for a period of two years.

Inspection Tours of the Administrative Officers.

3. The Surveyor-General left Calcutta on the 15th April and proceeded to Dehra, when he was summoned by the Government of India to Simla where he remained on special duty till the 27th. On the 28th he left Simla and returned to Dehra, to inspect the Trigonometrical Office and the field parties recessing at Mussooree, and again returned to Simla on the 10th May. During his stay at Simla he visited the office of No. 18 Party (Himálayas). On the 16th July Major-General Strahan left Simla and returned to Calcutta, again visiting the Trigonometrical Branch Office at Dehra and the field parties recessing at Mussooree. On the 11th September he left for Bangalore and Poona, where he inspected the recess offices of Nos. 10, 11, 17 and 21 Parties, till the end of the month, when he handed over charge of the department to Colonel St. G. C. Gore, R. E.

4. Lieutenant-Colonel J. R. Hobday, Deputy Surveyor-General, left Calcutta on 5th December for Burma, and inspected the following survey parties at work in the field, *viz.*:—No. 20 Forest Party at Pegu, No. 7 Cadastral Party at Toungoo, Mandalay and Myingyan, and No. 3 Lower Burma, Topographical Party at Prome, returning to Calcutta on 22nd idem. He then again left head-quarters on the 29th January to inspect the Bengal survey party in the field at Darbhanga and returned to Calcutta on the 8th February. At the request of the Government of India, he started again on the 12th February to

inspect and report on certain traverse operations in the Dera Gházi Khan district that were being conducted by Mr. R. B. Smart, Extra Assistant Superintendent, at the instance of the Punjab Government to help the local *patwári* surveys. He met Colonel Montgomery, the Settlement Commissioner at Sinánwán, and conferred with him regarding the work in progress under Mr. Smart, and the square system of surveying adopted by the Punjab Government. He left Bhakkar in the Dera Ismail Khan district on the 24th of February and proceeded to Tezpur to inspect No. 6 Survey Party in Assam, and finally returned to Calcutta on the 17th March.

He again left Calcutta on the 17th of April and inspected the Bengal Surveys recess office at Dígha near Dinapore, and continued on to inspect three of the field camps of the Land Records Surveys in the North-West Provinces and Oudh, at Gonda, Fatehgarh and Bareilly. He then proceeded to Mussooree to inspect Nos. 2 and 8 Traverse Parties, and continued on to Naini Tal to confer with His Honour the Lieutenant-Governor and the Board of Revenue regarding the transfer of Nos. 2 and 8 Traverse Parties and Drawing office to the control of Mr. G. B. Scott, the Superintendent, Land Records Surveys, North-West Provinces and Oudh, and other matters connected with the surveys in those Provinces, and finally returned to Calcutta on the 16th June. On the 2nd July he again left head-quarters to inspect the traverse detachment working in the Central Provinces and recessing at Jubbulpore, and then proceeded to Pachmarhi to confer with Mr. Ibbetson, the Chief Commissioner, regarding survey matters connected with those Provinces.

In August he inspected Nos. 3, and 9 and 19 Parties at their recess quarters in Bangalore.

5. Colonel St. G. C. Gore, R.E., Superintendent, Trigonometrical Surveys, visited Mussooree in June and inspected Nos. 22, 23 and 24 Parties recessing there, and in July he proceeded to Simla where he inspected No. 18 Party.

In September he left Dehra Dún for Karáchi and inspected No. 12 Party.

FIELD PARTIES.

6. The field operations of the year were carried on by two double and 17 ordinary parties. Of these, one party was employed on trigonometrical surveys; eight parties on topographical surveys; one double and two ordinary parties on forest surveys; two parties on cadastral surveys; one double and one ordinary party, and a detachment, on traverse surveys; and three parties on scientific operations. The operations of the Forest Survey Branch were continued during the year in addition to the above. The Land Records surveys carried on by local agency in the North-Western Provinces and Oudh, which are under the general superintendence of the Deputy Surveyor-General, Revenue Branch, have been included in this report under the head of Cadastral Surveys.

7. The following tabular statement shows the whole of these operations grouped according to the scope and nature of the work on which the parties were severally employed:—

Statement of Survey Operations and Parties.

No. of Party.	Nature and *locale* of operations.	Page in this Report.	Executive Officers.	Scale of Survey.	Administrative Superintendent.
	Trigonometrical Survey.				
24	Indian Triangulation .	17	Captain H. A. D. Fraser, R.E. Lieutenant H. H. Turner, R.E. Mr. J. Hickie . . .	.....	Supdt., Trig.
	Topographical Surveys.				
6	Assam	57	Captain C. W. H. Symonds, I.S.C. Mr. W. H. Penrose . .	2 inches = 1 mile for reduction.	D. S. G., Rev.
3	Lower Burma . .	19	Mr. T. E. M. Claudius .	1 inch = 1 mile for reproduction.	Ditto.

Statement of Survey Operations and Parties—contd.

No. of Party.	Nature and *locale* of operations.	Page in this Report.	Executive Officers.	Scale of Survey.	Administrative Superintendent.
10	Upper Burma	20	Lieutenant W. M. Coldstream, R.E. Captain F. W. Pirrie, I.S.C. Mr. G. D. Cusson	1 inch = 4 mile and 16 inches = 1 mile for reproduction.	D. S. G., Topo.
11	Ditto	21	Mr. P. J. W. Doran	1 inch = 1 mile for reproduction.	Ditto.
21	Ditto	22	Captain C. H. D. Ryder, R.E. Captain H. J. Hare, R.E. Mr. A. J. James	Ditto	Ditto.
12	Sind	23	Mr. C. E. Erskine Mr. F. A. Barker	2 inches = 1 mile for reduction.	Supdt., Trig.
14	Lushai	25	Captain C. L. Robertson, R.E. Mr. J. Keating	2 inch = 1 mile for reproduction.	D. S. G., Rev.
15	North-Western Frontier	27	Colonel R. A. Wahab, C.I.E., R.E. Lieutenant G. A. Beazeley, R.E.	1 inch = 1 mile, 2 inches = 1 mile and 6 inches = 1 mile for reproduction.	Ditto, Topo.
18	Himálayas, Punjab	28	Major W. J. Bythell, R.E. Mr. L. J. Pocock Mr. C. D. Potter	4 inches = 1 mile for reproduction and reduction to half scale, and 2 inches = 1 mile for reproduction.	Supdt., Trig.
	Forest Surveys.				
9 & 19	Madras Presidency	31	Captain A. H. B. Hume, R.E.	4 inches = 1 mile for reproduction.	D. S. G., Rev.
17	Bombay Ditto	33	Captain P. J. Gordon, I.S.C. Mr. C. E. Tapsell	16 inches = 1 mile, 8 inches = 1 mile and 4 inches = 1 mile for reproduction.	Ditto, Topo.
20	Lower Burma	35	Mr. L. J. Pocock Mr. T. E. M. Claudius Mr. C. W. Wilson	4 inches = 1 mile and 2 inches = 1 mile for reproduction.	Ditto, Rev.
	Forest Survey Branch.				
	Central Provinces	39	Mr. W. H. Reynolds	4 inches = 1 mile for reproduction.	I. G. Forests.
	Punjab	40	Ditto		
	North-Western Provinces.	41	Ditto		
	Burma	41	Ditto		
	Cadastral Surveys.				
4	Bengal	42	Captain R. T. Crichton, I.S.C. Captain C. W. H. Symonds, I.S.C.	16 inches = 1 mile	S. S. S., Bengal.
7	Lower and Upper Burma	48	Mr. T. E. M. Claudius Mr. E. J. Jackson Mr. E. G. Eittle	16 inches = 1 mile	D. S. G., Rev.
Land Records Surveys.	North-Western Provinces and Oudh.	51	Mr. G. B. Scott	16 inches = 1 mile	Ditto.
	Traverse Surveys.				
2 & 8	North-Western Provinces and Oudh.	53	Mr. B. G. Gilbert-Cooper	16 inches = 1 mile (skeleton plots).	Ditto.
6	Assam	57	Captain C. W. H. Symonds, I.S.C. Mr. W. H. Penrose	.....	Ditto.
Central Provinces Detachment.	Central Provinces Detachment	59	Mr. W. C. Price	.....	Ditto.
	Geodetic.				
22	India	60	Lieutenant E. A. Tandy, R.E.	.....	Supdt., Trig.
23	Ditto	62	Captain G. P. Lenox-Conyngham, R.E.	.....	Ditto.
	Tidal and Levelling Operations.				
25	India	64	Lieutenant H. L. Crosthwait, R.E.	.....	Ditto.

OUTTURN.

8. The total outturn of survey during the year amounts to 95,934 square miles, including 66,883 square miles of reconnaissance. During the previous year the area surveyed amounted to 36,199 square miles which is considerably less than this year's outturn. The increase this year is due to the large amount of reconnaissance in Yunnan and along the Burma-China boundary, etc., on the $\frac{1}{2}$ inch and $\frac{1}{4}$ inch scales, the former amounting to 2,043 square miles, and the latter to 64,840 square miles. The total area of rigorous survey on all scales is 29,051 square miles as compared with 26,223 square miles done last year. The traverse operations in the North-Western Provinces and Oudh, Assam, and the Central Provinces which were carried out for Cadastral purposes—to furnish the Settlement Department with skeleton plots on which field surveys are based—amounted to 4,334 square miles against 5,128 square miles done last year.

9. The operations are summarised in the following pages of Part I, and a more detailed report on the operations of each Field Party will be found in Part II.

TRIGONOMETRICAL SURVEYS.

10. Owing to the continued disturbed state of Makrán alluded to in paragraph 11 of last year's report the opportunity was taken to shift the *locale* of the triangulation party to Burma, to complete the connection between the Burma and Assam triangulation which had to be postponed at the close of the field season of 1895-96. By having two observers, Captain H. A. D. Fraser and Lieutenant H. H. Turner, observing simultaneously the Manipur Longitudinal Series was successfully completed and the Burma Triangulation linked up with the other Principal Triangulation in India. Opportunity was taken to have the angles at some of the stations of season 1894-95, re-observed, and the results proved that there had been no displacement in that part of Assam, from the great earthquake of 1897.

TOPOGRAPHICAL SURVEYS.

11. Eight parties have been engaged in topographical surveys during the year—an increase of one over those employed in the previous year due to the transfer of No. 3 Party from cadastral to topographical work.

Of these, four parties, *viz.*, Nos. 3, 10, 11 and 21 have been employed in Burma, and the remainder, *viz.*, Nos. 12, 14,15 and 18 in various parts of India.

12. Two of the parties employed in Burma, Nos. 11 and 21, were again occupied in mapping the Shan States. The ground under survey was similar to that of the previous year, hilly and intricate and covered with scrub jungle. These two parties were much weakened by calls on them to supply surveyors for the Burma-China Delimitation Commission, and consequently the outturn of the parties is lower than it would otherwise have been. The aggregate area surveyed by the two parties on the scale of 1 inch=1 mile amounted to 3,658 square miles, 6,650 square miles of triangulation being also completed.

The average cost rate for the topography is ₹15 per square mile, which compares very favourably with the previous year.

13. Of the other two parties employed in Burma, No. 10 has had the country west of the longitude of 96° 30′ in Upper Burma allotted to it, while No. 3 Party is employed in Lower Burma. A good deal of the work of the former consists in filling in topographical detail omitted by the surveyors when the districts were under cadastral survey.

The party completed an area of 2,338 square miles of topography on the 1 inch scale at a cost of just under ₹20 per square mile. In addition 2,798 square miles of triangulation in advance of detail survey was executed.

A large scale survey on the scale of 16 inches=1 mile of the station of Maymyo was also commenced which will be completed during the coming year.

No. 3 Party which was converted from a cadastral into a topographical one was employed in Lower Burma on the detail survey, on the 1 inch scale, of the ground lying between the crest of the Arakan Yomas and the River Irrawaddy.

The greater portion of the area under survey was uninhabited hilly country covered with dense forest, and with very few roads, and considering that this was the first year in which this party had worked as a topographical one, their outturn of 1,963 square miles of topography and 3,512 square miles of triangulation is very creditable. The cost rates, R28·8 for topography and R5 for triangulation, are low for the class of country under survey. The party unfortunately suffered a good deal in health owing to the malarious nature of the country.

The total result of the season's work in Burma is an addition to our topography of 7,959 square miles.

14. No. 12 Party continued the topography of Sind on the scale of 2 inches to a mile. An area of 2,813 square miles was surveyed and mapped on the 2-inch scale at an average cost of Rs. 13-1 per square mile, while the larger scale city survey cost R 140-1 per square mile; this last rate includes the cost of the extra triangulation and traversing which had to be carried out in order to give the topographers a sufficiency of points for their work. An area of 3,850 square miles was prepared for future topography by the usual triangulation and traversing and some additional bench-marks laid down by the Irrigation and Railways were connected with the triangulation and their heights fixed.

15. The survey of the Lushai Hills, which was commenced last season, has been carried on with fair success.

The secondary series of triangles which will form the backbone of all future triangulation in this part has been carried through and completed, and in addition minor triangulation has been extended over an area of 1,423 square miles.

Owing to all absence of data on which to found a fair estimate of the rate of progress in such country, the actual outturn of topography did not quite come up to what was expected, an area of 649 square miles having been completed.

On account of the great physical difficulties of the country and the necessity of importing all food supplies, it is impossible to work a large party on this survey and a comparatively high cost rate will be inevitable. That of the present season is R64 per square mile for topography alone. It is not fair, however, to judge this by the result of a first season's work in new and difficult country, and no doubt the rate will be considerably reduced in future years.

16. No. 15 Party as usual was employed on various surveys required by the Military Department mainly in the Ráwalpindi district and in Kashmir, a special survey of the coal-bearing area on the Sor Range near Quetta having been also made. A detachment of this party was, as heretofore, employed on the 1 inch survey of the western hilly portions of Sind.

17. No. 18 Party completed a total area of 778 square miles in the Kángra and Hoshiárpur districts, and in the Sirmúr and Simla Hill States. This area included 156 square miles of the Kángra district surveyed on the 4-inch scale and 622 square miles surveyed on the 2-inch scale. Classification of forests and soils was carried out in 312·4 square miles.

The survey of the town of Náhan on the scale of 48 inches=1 mile, which was begun last year, was completed, and at the special request and expense of the State the Cantonment at Náhan was surveyed on the same scale.

18. The total area of country topographically surveyed during the year, on various scales, from 1 inch to 1 mile upwards, amounted to 18,280 square miles against 15,109 square miles completed the previous year.

The total is made up as follows:—

		scale.
13,096	square miles surveyed on the	1-inch.
4,849	" " " "	2-inch.
104	" " " "	4-inch.
223	" " " "	6-inch.
8	" " " "	16-inch.

FOREST SURVEYS.

19. The special surveys of Government forests on various scales are carried out in part by the Forest Survey Branch and partly by the Survey Department. From the 1st April of the year under report the Imperial Survey Party working in the forests in Burma (No. 20) was transferred to the Forest Survey

Branch, and eventually it is hoped that these surveys will be all carried out under one administrative officer of the Imperial Branch of this Department, thus giving the Surveyor-General greater professional control over them, in addition to securing more uniformity of procedure.

During the year surveys were carried out in Burma, Madras and Bombay and in part of the Himálayas by the Imperial Parties, and in the Central Provinces, Punjab and Burma by the Forest Survey Branch.

20. In Madras the two parties, Nos. 9 and 19, which had been amalgamated into a single one last year, were further reorganised and put under charge of a single Imperial officer.

Surveys of reserved forests were carried on in the Kurnool, Cuddapah and North Coimbatore districts.

The reorganisation and further familiarity with the work had the effect, notwithstanding the difficulties of the country under survey, of largely increasing the outturn and diminishing the cost rate: 1,350 square miles of 4-inch survey having been completed at a total cost rate of R74 per square mile, which is very satisfactory. The health of the party was somewhat better than in the previous year.

21. In Bombay the Forest Surveys were carried on as heretofore on three different scales. The bulk of the topography, that of the ordinary forest reserves, is mapped on the 4-inch scale, that of the special teak reserves on the 8-inch scale, while small areas of *bábul* reserves are surveyed on the 16-inch scale.

During the year surveys on the two smaller scales were carried on in the Thána, Násik, Kolába and North Kánara districts, and on the 16-inch scale in Ahmednagar and Sholápur districts.

The areas surveyed were, on the 4-inch scale 429 square miles, on the 8-inch scale 254 square miles, and on the 16-inch scale 55 square miles. The cost rates are very satisfactory, that for 4-inch work being about the same as for the last year, while those for the 8-inch and 16-inch work are very considerably less.

The health of the party during the field season remained good, though during the recess they suffered somewhat from the ravages of plague.

22. In Lower Burma, No. 20 Party continued the survey of the forests located there, the work being carried on in the Pegu, Shwegyin, Thayetmyo and Rangoon Forest divisions. The country met with was very difficult for survey work, the hills being very intricate and densely jungle covered. As usual food depôts had to be established and provisions distributed from them to the various squads. The area surveyed comprised 472 square miles on the 4-inch scale and 87 square miles on the 2-inch scale, the latter scale being employed for unreserved forests which were surveyed to fill up gaps in the sheets. In addition 1,200 square miles of triangulation and 186 square miles of traversing were completed. The cost rates were satisfactory, that for the 4-inch detail survey and for triangulation being the lowest recorded by this party as yet, though the cost of traversing was considerably higher than of late years, the enhanced rate being in part owing to the fact that the officer in charge had himself to undertake the traversing. The health of the party was on the whole good, though unfortunately three *khalásis* were carried off by tigers.

23. The Forest Survey Branch continued its operations in the Central Provinces, the Chamba State and Montgomery district of the Punjab, in Oudh and in Upper and Lower Burma.

In the Central Provinces an area of 1,780 square miles was surveyed, of which 1,454 square miles were mapped on the 4-inch scale and 326 square miles on the 16-inch scale, the latter comprising work along the forest boundaries.

In the Punjab, with the exception of some boundary traversing in the Montgomery district, work was confined to the Chamba State where a number of forests are leased by Government from the Raja. One hundred square miles of these leased forests were surveyed on the 4-inch scale and 953 square miles of the outlying portions were mapped on the 1-inch scale in order to complete the topographical map of the State.

In Burma work was carried on in the Ruby Mines, Pyinmana and Salween-Ataran Forest divisions, and an area of 377 square miles of survey completed.

24. The total outturn of Forest Surveys executed on various scales during the year amounts to 5,217 square miles, of which 2,257 square miles were surveyed by the Forest Survey Branch. The area surveyed by the Imperial Survey Parties amounts to 2,960 square miles, being an increase of 563 square miles over that completed last year.

Classed by scales the figures are as follows:—

		scale.
347	square miles surveyed on the	2-inch.
4,234	" " " "	4-inch.
255	" " " "	8-inch.
381	" " " "	16-inch.

CADASTRAL SURVEYS.

25. During the year under report there was one cadastral survey party in Burma administered directly by the Deputy Surveyor-General, one in Bengal, and one in the North-West Provinces. The two latter are under the general professional superintendence of the Deputy Surveyor-General, whilst the programme and cost of operations are entirely under the control of Local Governments.

26. The Burma party completed an area of 711 square miles in Lower Burma (Toungoo district) and 109 square miles in Upper Burma (Myingyan district). No traverse operations were undertaken by this party, since there was a sufficiency prepared in advance of detail survey in Upper Burma, *viz.*, in the Lower Chindwin district. No writing of records is done by the Survey Department in Burma. The survey operations in Upper Burma having advanced so far ahead of the settlement, it is considered that an annual outturn of about 800 square miles by the cadastral party will suffice for the next few years to enable the settlement to overtake the survey. A separate establishment is kept up in this party to complete the mapping of the districts cadastrally surveyed, and to assist the Settlement Department in many ways as their work progresses.

27. The Bengal party completed an area of 607 square miles in Sáran, and 684 square miles in Darbhanga district. In addition, 267 square miles were traversed in Sáran, 619 square miles in Darbhanga, 95 square miles in Champáran and 726 square miles in Sonthal Parganas.

The cities of Darbhanga and Chapra were traversed and surveyed, the former on the scale of 64 inches = 1 mile, and a portion of the latter on the scale of 16 inches = 1 mile. Minor miscellaneous work, topographical and traverse, was carried on, in districts Champáran and Sháhabad of the Patna division, and for the rectification of boundaries in Kachnar and Banskati *mahals*, the Nepál Frontier, etc., etc.

In Bengal the work of the record-writing is done by the Survey Department, and there is nothing remaining for the Settlement officers to do but the attestation. The detail survey is carried on entirely with *amins*.

28. The cadastral survey and writing of records were continued in the North-West Provinces.

29. The total area cadastrally surveyed was 3,314 square miles in the following districts:—

	Square miles.
Bareilly	345
Kheri	284
Pilibhít	425
Do. Bisálpur Tahsíl	162
Farrukhabad	867
Azamgarh	587
Gonda	623
Naini Tal	21

Districts Bareilly and Kheri and the hill *parganas* of Naini Tal were completed during the season under report.

30. The detail survey was conducted entirely by *patwáris* except in Naini Tal, where there are no *patwáris*, and in portions of Farrukhabad and Pilibhít districts where it was required to complete certain small areas expeditiously or where they were situated in difficult and scattered localities.

31. The total areas cadastrally surveyed during the year in the different Provinces are as follows :—

	Square miles.
Bengal	1,420
Burma	820
North-West Provinces and Oudh	3,314
TOTAL	5,554

TRAVERSE SURVEYS.

32. During the year under report there was one double party in the North-West Provinces and Oudh, one party in Assam, and a detachment in the Central Provinces.

33. The party in the North-West Provinces completed an area of 3,800 square miles in districts Farrukhabad, Etáwah, Mainpuri, Etah, Azamgarh and Gonda, also an area of 164 square miles of topographical survey, in districts Sháhjahánpur and Kheri, and the Lalitpur sub-division of Jhánsi district.

34. The Assam party traversed an area of 1,076 square miles in the Assam and Surma Valleys and topographically surveyed an area of 1,144 square miles on the 2-inch scale of the Brahmaputra Valley, in districts Nowgong and Sibságar. This party ceases to exist from 1st November 1899, but a detachment will remain in the Province to undertake the traversing of extensions of cultivation and the upkeep of topographical maps and other miscellaneous work that may be needed by the Local Government.

35. The detachment in the Central Provinces completed the traversing of 147 square miles of *raiyatwári* excisions in districts Chhindwára and Betúl, 300 square miles in the Chhindwára *Jagírs* and 31 square miles in the Bilás-pur district.

36. The areas traversed during the year, excluding the traversing done by the cadastral parties for their own surveys, are as follows :—

	Square miles.
North-West Provinces and Oudh	3,800
Assam	1,076*
Central Provinces	478
TOTAL	5,354

SPECIAL OPERATIONS.

37. The two Astronomical Parties Nos. 22 and 23 were employed in continuing the latitude observations. No. 22 Party worked along the East Coast Series. Observations having been taken at 8 stations.

Captain G. P. Lenox-Conyngham who was in charge of No. 23 Party continued the system of determining latitudes in groups, referred to in paragraph 32 of last year's report. Observations for latitude and azimuth were taken at 8 stations forming a group round Kaliánpur H. S. the origin of the Indian Survey. Owing to the increased amount of computations the observations could not be sufficiently analysed to draw any conclusion from the results.

38. The tidal observations have been continued as usual. Automatic registrations with self-registering tide-gauges were continued at 13 stations in India, Burma, the Andaman Islands, the Persian Gulf and the Red Sea, and in addition a series of personal tidal observations to graduated staves alluded to in paragraph 33 of last year's report, was continued at 6 stations with the object of comparing the actual times and heights of high and low water with those predicted in the tide-tables. The observations at Diamond Island having been completed, it is proposed to close this station and to start work at Port Albert Victor during the ensuing season.

39. The levelling operations, suspended last year, were resumed and the line of levels was continued from Katni to Allahabad, thus completing another chain from Karáchi on the west to Vizagapatam on the east. In addition, a branch line was run from Katni along the Indian Midland Railway to Kethora and from thence to the two ends of the Sironj Base line. The total outturn amounts to

* Of this area 1,020 square miles was for topographical survey on the 2-inch scale.

378¼ miles of double levelling, fixing the heights of 33 embedded bench-marks, 331 ordinary bench-marks, 94 Railway bench-marks, 11 P. W. D. bench-marks and 8 stations of the Great Trigonometrical Survey.

40. The Government of India having decided to undertake a magnetic survey of India, Captain H. A. D. Fraser, R.E., who had gone home on furlough was deputed to consult Professor Rücker on the matter, to proceed to Kew and to make a study of the subject, and to arrange about providing suitable instruments.

As these have to be made especially to order, there is no probability of the actual survey commencing before the end of the year 1900.

GEOGRAPHICAL SURVEYS AND RECONNAISSANCES.

41. Under this head are included surveys and reconnaissances which are executed on the scale of ½ inch to 1 mile or smaller scales. During the year an area of 2,043 square miles of survey on the scale of ½ inch=1 mile was completed in Kashmir and Gilghit, and a very large addition made to our knowledge of the geography of our frontiers, amounting to some 65,000 square miles of geographical reconnaissance on the ¼ inch scale.

HEAD-QUARTERS OFFICES.

42. The details of the work done in the various offices at head-quarters are given in Part III of this Report.

43. The offices in Calcutta were supervised by three Assistant Surveyor-Generals: Mr. A. E. Spring remained in charge of the Drawing, Engraving and Map Record and Issue Offices and also held charge of the Bengal Provincial Drawing Office, and Mr. T. A. Pope continued to supervise the Photographic and Lithographic Offices. The Correspondence Office was, at different periods in the year, under Captain H. A. D. Farser, R. E., Lieutenant G. A. Beazeley, R. E., Major S. G. Burrard, R. E., and Captain P. J. Gordon, I. S. C., and the Mathematical Instrument Office was in the hands of Lieutenant-Colonel J. R. Hobday, I. S. C., Major W. J. Bythell, R. E., Captain H. A. D. Fraser, R. E., Lieutenant G. A. Beazeley, R. E., and Major S. G. Burrard, R. E.

44. The Geographical Section of the Drawing Office has as usual been employed on the work of completing and keeping up to date the maps of the North-Eastern and South-Eastern Frontiers. Sheets No. 15 S. E. (6th edition), 22 S. W. (2nd edition) on the 4-mile scale, were brought up to date and published, and sheets No. 22 (6th edition) and 23 (2nd edition) on the 8-mile scale were also corrected, brought up to date and published. Of the South-Eastern Frontier Series, sheets No. 2 S. E. (5th edition), 2 S. W. (2nd edition), 4 N. W. (6th edition), 5 S. W. (6th edition), 6 N. W. (7th edition) were added to and published. Upper Burma sheets Nos. 305, 306 (2nd edition), 307, 315, 351, 352, 353, 358, 360, 361, 362 on the 1-mile scale were completed and published, and sheets Nos. 304, 350, 398, 399, 402, and 458 are now under publication; sheets 260 (2nd edition), 316, 400, 401, 403, 404, 405, 406, and 407 are very nearly completed and will be published early next year; sheets 313 and 314 of the same series had their boundaries revised and brought up to date. The general maps of India on various scales have been corrected and brought up to date; the 32-mile map of India (3rd edition) was published early in the year; the new Railway map of India on the 32-mile scale showing railway and steamer stations was completed and sent to press and will be published shortly. The Military map of India on the 32-mile scale is still under preparation and will be completed early next year. The provincial maps on the 16-mile scale were all more or less corrected and brought up to date; those of the Bombay Presidency, the Madras Presidency and of the Punjab, had the hills brush-shaded and sent for engraving. A large number of maps were prepared for the Military and other Departments, among them a series of maps to illustrate Mr. Grierson's work in connection with the Linguistic Survey and some for Mr. Forrest's work on the Indian Mutiny of 1857.

45. The work of the Revenue Section has been mainly of the usual routine nature. The map of "City of Calcutta and Suburbs" (in two sections), on the scale of 6 inches=1 mile is at press. Five standard sheets of district

Pesháwar, a map of Calcutta and 10 miles of surrounding country on the 1-inch scale, and a map of the Civil station of Basti on the scale 8 inches=1 mile, have been compiled and published. The 2-inch map of Calcutta and 10 miles of surrounding country was also compiled and is in press. Six standard sheets for the North-Western Provinces and Oudh, (two sheets on the 1-inch scale and four sheets on the 4-inch scale), and four standard sheets for the Bombay Presidency, have been published. Sheet No. 389 of the Bengal series has been compiled from the old main circuit maps. One district in the Punjab and three in the Central Provinces have had the office copies on the 1-inch scale corrected from tracings supplied by the Settlement Department. Of the large scale maps press order was given on 19 sheets on the scale of 1 inch= 50 ft. of the Moulmein Town maps, and for 191 sheets on the scale of 1 inch =50 ft. of the Rangoon Town maps: 154 originals of the Rangoon Town maps on the scale of 1 inch=100 ft. were sent to press for reproduction. Of the office copies 17 standard sheets and 26 *pargana* maps of Bengal, 9 standard sheets and 7 *pargana* maps of the Central Provinces, 2 standard sheets of Bombay, 7 *pargana* maps of Assam, 2 standard sheets of the North-Western Provinces and Oudh, and 16 Cantonment maps, on various scales, were revised and corrected as to their boundaries and brought up to date; twenty (old) standard sheets of the Punjab, 45 *pargana* maps of Bengal and 7 of the Central Provinces were touched up, corrected and brought up to date for republication. Of the district maps on the $\frac{1}{8}$-inch and $\frac{1}{4}$-inch scales, 4 districts of the Punjab, one of Bengal, and 2 in the Central Provinces were corrected and brought up to date from information supplied by the local authorities.

46. In the Cadastral Section 4,609 sheets were published of which 633 belonged to the North-Western Provinces, 3,431 to Burma, 289 to Bengal (Tikári Ward's Estate, District Gaya) and 256 to Assam.

47. The Bengal Provincial Drawing Office continued to be employed on the compilation of standard sheets on the scale of 2 inches=1 mile for reduction to half scale, by photography, from the cadastral maps of Bihar, Orissa and Chittagong. The outlining of 6 standard sheets in 24 sections of Bihar was completed and 32 sections were sent to the Photographic office for reduction to the scale of 1 inch=1 mile. The outlining and examination of the Orissa standard sheets was completed and 4 sheets in 16 sections were sent to the Photographic office for reduction to the scale of 1 inch=1 mile. The whole of the cadastral maps of Chittagong have been reduced by pantagraph to the scale of 2 inches=1 mile, and the outlining of 4 standard sheets in 16 sections was completed during the year under report. Of the special publication of 26 standard sheets of Orissa on the scale of 2 inches=1 mile called for by the Government of Bengal showing the irrigated areas, 9 sheets were published during the year under report.

48. In the Engraving Office the work has been steadily pushed forward. The quarter sheets of the Atlas of India being principally worked upon; eight new sheets have been published, 63 new quarter sheets in various stages of progress have been added to with the most recent surveys. Fifty published quarter sheets and 15 full sheets have been corrected and brought up to date for printing, while 29 plates have been projected or had the borders cut on them. A new map of India on the 64-mile scale has been projected; the published map on the same scale, the 80-mile and the 96-mile maps have been in hand to bring the railways up to date; the hills have been well advanced on the 128-mile map and have just been started on the 256-mile map of India. Of the 16-mile provincial maps, Bengal in 2 sheets and the Bombay Presidency, have had some new materials added to them; Central India, Central Provinces, and Rájputána, all in 2 sheets, Gujarát and Madras in 6 sheets have all been in hand for corrections and additions. The four sheets of the map of the Punjab and Kashmir both with and without hills have been in hand and large additions are in progress in sheets 1 and 3. Thirteen district maps for administration reports have been completed and published, while fifteen others, 6 Index maps, 5 charts, 4 imprint and note plates have been in hand for correction. Three new tint plates have been completed and 53 plates have had titles and footnotes cut on them for the Photo.-Litho. Office. The Copper-plate Printing Section pulled 18,624 impressions and the Steel-facing Section dealt with 236 plates.

49. The scheme for the reorganisation of the Photographic and Lithographic Office, having received the sanction of the Secretary of State for India, came into effect on the 1st December 1898, and has been found to work smoothly and well during the past year. The technical sections of the Trigonometrical Branch Office at Dehra Dún have now been amalgamated with this Office for the purposes of promotion, and all posts carrying progressive salaries have been abolished, with the exception of a few which will, as a rule, be filled by men trained and appointed in Europe. Under the new arrangements every man in the Office knows precisely what amount of promotion he may reasonably expect during his term of service, and the feeling of uncertainty as to their future prospects felt by all the assistants while under the old rules has been entirely removed. The financial result of the scheme is a small saving to Government, effected by the abolition of one of the more highly paid posts and the substitution for it of several posts in the lower grades.

The amount of work received for reproduction during the year is considerably in excess of that received last year. The work sent in by other departments and Government officials has increased very largely, and it has been found impossible to fulfil these heavy demands, and at the same time to keep the current departmental work from falling into arrears. The publication of a large number of the standard sheets of the Topographical and Revenue Surveys has been seriously delayed during the past year by the urgency of the demands made upon the Office by other departments; and as it is not to be expected that these demands will lessen in the future, but rather that they will continue to increase, the question of strengthening the establishment in certain sections of the Office, which are undermanned, will shortly require consideration. It is impossible to allow the publication of departmental maps, which forms the legitimate and most important work of the Office, to fall into arrears, in order that other work, however urgent, may be undertaken. At the same time it is undesirable to decline work sent in from outside, such as military maps for manœuvres, weather charts for meteorological purposes, administration report maps, railway maps and diagrams, etc., which cannot be executed elsewhere, and are useless if not supplied within a given time. The printing power of the Office has been increased of late years, and is now equal to any demands that are likely to be made upon it, but the establishment has remained practically the same for many years past, and a small increase to it is now absolutely necessary if arrears are to be avoided.

The number of original subjects dealt with during the year was 6,873, as against 6,364 last year. Of these the number of departmental subjects (normal and cadastral) is slightly more than last year, *viz.*, 5,349, as against 5,262, while the number of extra-departmental subjects increased from 1,102 to 1,524. The printed outturn, excluding type work, amounted to 965,453 copies, of which 135,094 were of ordinary departmental maps, 136,630 of cadastral maps, and 693,729 of extra-departmental maps and plans. Nearly three-fourths of the whole outturn of the presses and machines was thus executed for other departments. Last year the total number of copies printed was 695,812, of which 156,155 were departmental maps, 94,328 cadastral maps, and 445,329 extra-departmental subjects. The increase of cadastral work is owing to the fact that the outturn consisted of Burma and Assam sheets, of which more copies are required than of the North-West Provinces sheets, which formed the bulk of last year's outturn. The number of pages or items set up in the Type-printing Section was 13,932, or 113 in excess of last year. The number of pulls was 1,277,949, or 101,112 more than last year and of copies, 684,039, or 16,717 less than last year. The Heliogravure Section again shows a considerable increase; 128 plates were etched, yielding 86,514 prints or 27 plates and 12,713 prints in excess of last year's outturn. The number of blocks made by the Enamelline process was 78, yielding 12,100 prints, as against 82 blocks and 8,100 prints last year. The total value of the work done in all sections amounted to R2,17,622, which is R24,696 in excess of the value of last year's outturn.

The more important publications of the year are referred to in Part III, and full details of the work done in every section will be found in the Appendix.

50. In the Map Record and Issue Office the number of new maps and editions of departmental subjects received during the year amounted to 4,591, of which 4,239 were cadastral maps. The total number of maps issued was

1,94,848, and their value R2,15,195, which shows an increase of 38,325 in number and R97,253 in value, on those of the preceding year. The cash sale of maps amounted to R29,916, which also shows an increase of R1,602, over the cash receipts of the past year.

51. In the Mathematical Instrument Office the total number of instruments issued was 72,514, and their value R2,59,435 against 59,100 and R2,83,857, for the previous year. The number of instruments received into store was 61,407, and their value R2,84,208, against 54,256, and R2,61,816 last year. There has been an increase in the number of instruments issued during the year, but their value is less; there has also been an increase both in the number and value of instruments received. The number of instruments taken from the repairable stock and rendered serviceable was 4,118, and their value R1,07,967, against 5,250, and R1,06,055 last year. This shows an increase in value though a decrease in number.

The conversion of old pattern levels and theodolites has been steadily continued and 71 levels, obsolete patterns, have been converted into serviceable instruments and issued. Since the increased establishments for the repair of instruments have been sanctioned, 487 levels and 192 theodolites have been converted and issued and, except in the case of special patterns for definite purposes, indents for such instruments have been discontinued. The value of instruments indented for during 1899-1900, from England amounted to £5,174. This shows a small increase over last year's figure.

52. In the Trigonometrical Branch Office at Dehra Dún a commencement was made with the preparation of the North-East Longitudinal Series for the press. The reduction of Captain Deasy's and other exploration work entailed heavy computations. A catalogue of circumpolar stars was computed for the use of the Trigonometrical Parties.

The usual meteorological and solar photographic observations were continued. The results obtained with dry plates in the photoheliographic work have been so successful that it is expected they will, in time, supersede the wet plates. This is all the more satisfactory, as on cloudy days during the monsoon many a negative was spoilt by the quick drying of the wet plates.

The reproduction of maps for the forest department in various colours has entailed a heavy pressure of work on the small photozincographic section.

The Training School has continued to do good work and the class just passed was the largest the school is likely to have for some years to come. Seven officers of the Imperial Service went through a practical course of trigonometrical, topographical and astronomical work. Thirteen of the Provincial officers were put through a course extending over the whole year and were then posted to field parties. In addition fifteen Sub-Surveyors satisfactorily passed through a course fitting them for topographical surveyors.

53. The head-quarters offices of the Forest Survey Branch at Dehra Dún were under the supervision of Mr. W. H. Reynolds, Superintendent of Forest Surveys, and were employed as usual upon correspondence and accounts, and final computations in connection with the work of the several field detachments of the Forest Branch; the maintenance of Forest records; the compilation and drawing of special maps and other miscellaneous work for the Forest Department; and on the training of men for forest survey work. During the year 5 index maps on various scales, 169 standard sheets on the 4-inch scale and 29 standard sheets on various scales were published. In addition to the above 3,274 printed maps were coloured, 440 tracings were prepared and 2,230 printed maps were mounted in book form for the Forest Department and District Officers.

ESTABLISHMENT.

54. During the year the Department has lost the services of two officers of the Imperial Service.

Major-General C. Strahan, R. E., Surveyor-General of India, retired from the Department in which he had served for the last 36 years, on the 30th September 1899, the close of the survey year.

General Strahan, who was the last of the Bengal Engineers, received his first commission from Addiscombe, on the 8th June 1860 at the early age of 17. He came out to India in 1862, was appointed to the Survey Department on the

26th September 1863 and posted to the Central India Topographical Survey in which he remained nearly 17 years, when he was transferred to the Rájputána Topographical Survey for 3 years. In 1883 he was appointed Assistant Surveyor-General and rose through the post of Deputy Surveyor-General, Revenue Branch, to be Surveyor-General in 1895 from which position he has now retired.

General Strahan had a very wide grasp of general scientific matters as well as great administrative ability and a thorough mastery of Topographical Surveying and his loss will be greatly felt by the Department in all its branches. The Government of India have been pleased to place on record their appreciation of the professional reputation and eminent service rendered to the State by the Department during the period it was under his control.

Mr. G. W. E. Atkinson, Officiating Deputy Superintendent, 1st grade, retired from the service on superannuation on the 11th October 1898. He joined the Junior Division (now the Provincial Service) of the Trigonometrical Branch on the 1st August 1859, and after varied service was promoted to the Senior Division (now the Imperial Service) on the 8th November 1892.

Mr. Atkinson was for many years in charge of the Trans-frontier Geographical mapping, and had acquired a very considerable knowledge of the subject.

55. In the Provincial Service the Department has lost the services of five officers during the year, *viz.*, three by the retirement of Messrs. L. J. Pocock, W. S. Buttress and P. White and two by the deaths of Mr. A. H. Peychers and Rai Bahadur Hira Singh.

RETROSPECT.

Remarks on the progress of the Operations since March 1895.

56. Major-General C. Strahan, R.E., the late Surveyor-General, having been unable to draw up the report on the operations of the department during this the last year of his tenure of office, requested that the following might be included in it.

"A few remarks on the progress made in the different branches of the department since March 1895, when Sir H. Thuillier retired, and the work remaining to be taken up may be of interest.

"In 1896, Colonel Sandeman submitted to Government a scheme by which the different Local Governments and Administrations of India should be allowed to prosecute their own cadastral and other surveys under the management of officers trained in the Survey Department, who were to be lent to them: this system had already been introduced into Bengal with success and a few months before Sir H. Thuillier left, an officer was deputed to carry on similar operations in the North-West Provinces; during the coming field season he will have under him a staff consisting of a Royal Engineer officer and 16 Provincial officers and the outturn will be about 4,000 square miles a year. In addition to these there is a Drawing Office, the duty of which is to prepare the 1-inch standard maps from the 16-inch settlement maps of the cultivated areas and to fill in the gaps by topographical survey. To the Central Provinces an experienced Provincial officer has been deputed to supervise the traverse operations and to otherwise assist the Local Administration in carrying out their local surveys on a correct basis.

"Another Provincial officer has been nominated for the same purpose in the Punjab, and a third officer is now on deputation to Assam. For all of these Drawing offices must be organised; one for the Central Provinces is urgently wanted.

"The duty of these Drawing offices will be not only to prepare in the first instance the 1-inch standard sheets as already mentioned, but also to bring those already published up to date and hereafter to continue keeping all maps of the Province up to date. For this most important duty no proper provision has ever been made, and if not dealt with, will in years to come necessitate great expenditure in making entire resurveys. Arrangements have been made with the sanction of the Bengal Government by which at a trifling annual cost, the map of Calcutta on the scale of 50 feet to the inch, which was published about 1893, will be always kept up to date and no resurvey will ever be required until one on a still larger scale is found to be necessary. This is what is wanted for the whole of India, but which it is quite impossible for any one Central Office to attempt to carry out; it can only be done by some system of dividing the labour, such as is

being done by these Provincial Survey establishments with their attached Drawing offices.

"For many years the Topographical Parties had complained of the difficulty of training new hands in the field and of the time wasted by the older men in training them; moreover, it was said and with truth that at best the men were not well trained. To remedy this a training school for native surveyors was organised at Dehra Dún and this has since been enlarged, until it has now become an important institution under the Superintendent, Trigonometrical Surveys, at which all Imperial and Provincial officers, as well as native surveyors, go through a course of instruction. It is doing admirable work, but is unable to train native surveyors fast enough to supply the demands of our Topographical Parties and those of foreign countries.

"During the last 3 or 4 years the calls on the Department to provide trained surveyors for work out of India have been increasing and are now so many that we cannot supply them without detriment to our own work. In addition to surveys for Boundary Commissions and Military Expeditions, which may be looked upon as part of our legitimate work, we have been asked for and have furnished surveyors for Africa, China, Zanzibar, and a detachment under two European officers is under orders to survey the added area in Kwang Tung. It is not only on the topographical branch that such demands are made, but they extend also to the cadastral and trigonometrical branches; for we have supplied four Provincial Officers to Siam and a retired Survey Officer who has taken service under the Siam Government is now in India recruiting native Surveyors for that country; and again not long ago I was obliged to refuse to send to the Straits Settlement some natives experienced in trigonometrical work, for want of men to spare. In consequence of these increasing demands I consider that the department should at all times be kept up to its full strength in both the Imperial and Provincial Services.

"The scientific branch has not been idle; the electric determination of the difference of longitude between Karáchi and Greenwich has been finally determined with a probable error of about o".33; the principal series of triangulation through Makrán to Persia was started, but owing to the political rising in those parts during which our officers narrowly escaped with their lives and several natives were killed, it came to an abrupt conclusion and has not yet been started again. A junction has been made between the principal triangulation in Burma and that in India, the result of which has been to prove that the most eastern stations, near Manipur, to which the Indian work had been carried, had not been disturbed by the earthquake in Assam. It had been previously ascertained by means of some carefully executed secondary triangulation that the hills to the west of Shillong had been perceptibly thrown out of position, both horizontally and vertically, but neither the actual amount of the displacement nor the area over which it extended could be ascertained, as it was evident that all the stations visited lay within the affected area. This being so, the Superintendent, Geological Survey, asked for sanction to have the whole of the triangulation in that part of Assam rigorously revised; as however the junction now made has proved that such revision is not necessary for geodetic purposes, the Government of India have decided that it is not worth incurring such a heavy expense. I still hope, however, that this may some day be sanctioned, when the finances are in a more favourable condition, as I believe it is almost the only case in which it is possible to determine with accuracy the actual displacement of the earth's crust over a large area due to an earthquake. Tidal observations have been extended to the Red Sea and observatories have been established at Perim and Suez.

"Arrangements have been made to start the first magnetic survey of India, and it was hoped that a commencement would have been made this field season, but this is now impossible as the necessary instruments cannot be procured till October 1900.

"Great progress has been made in topographical surveys, more especially in Burma, where four topographical and one forest survey party are at work, besides yet another small party in the Lushai Hills. The whole of Burma and the countries between Burma and Bengal have now been allotted to some one of these parties. The resurvey of the whole of Sind was commenced in 1895-96, and about 4,000 square miles a year are being mapped.

"Only one cadastral party is now being carried on, on the old lines, and that is working in Burma. The survey of the cultivated areas in the Assam valley

and in Cachar of which the Local Government wanted cadastral maps has been finished, but there are large permanently settled tracts in Cachar which have not been mapped since the original survey 40 or 50 years ago. Portions of the North-Western Provinces were cadastrally surveyed on the old system previous to 1895, but as already mentioned the remaining districts are being surveyed by local agency under our officers.

"The areas completed since 1895 by the topographical, forest and cadastral surveys are as follows :—

	Square miles.
Topographical Surveys	89,235
Forest Surveys	23,314
Cadastral Surveys	35,263
Traverse Surveys	29,704
Geographical Surveys or Reconnaissances	278,456

"No allusion so far has been made to the large Head-Quarters Offices, in Calcutta nor to the Trigonometrical Branch Office in Dehra Dún. The actual number of maps examined, printed and issued, the number of instruments manufactured or repaired and issued, and all the other work performed in Calcutta can be seen in the annual reports. In almost all the different branches work is steadily increasing and it is almost certain that not many years hence an enlargement of the office will be required. The copper-plate printing establishment is much below the strength it should be and it is accumulating arrears at an alarming pace, but it is impossible to strengthen it for want of space. We have been forced to take a house in which to accommodate the Bengal Drawing Office for want of room. The Trigonometrical Branch Office is also much too cramped and some addition to that is urgently wanted, and I hope Government will carry out my successor's proposal when he submits it. The clerical and other establishments of these different offices, which up till now have always been in separate cadres, and difficult to deal with in respect to promotions, etc., have all been remodelled and amalgamated like to like, which much simplifies such questions and greatly accelerates promotion in the smaller offices.

"As the question is sometimes asked as to when the Survey of India will be completed, it will not be amiss to mention some of the areas still remaining to be surveyed for the first time, as well as those which have been reconnoitred only, and require resurvey or of which the maps have become out of date.

"In the North-Western Provinces there are nine districts aggregating an area of over 17,500 square miles, which have never been accurately surveyed at all; the existing maps are based on rough settlement surveys made many years ago, of other parts the maps require revision. All this has been provided for by the local survey establishment.

"The maps of, by far the greater part of, Bengal and Cachar are so old as to be of but little use now; the changes of rivers in many places are so great as to make it impossible to trace the rivers along which the steamers ply. No provision has been made in either Bengal or Cachar to resurvey these areas.

"Of upwards of 35,000 square miles in the Punjab, we have no reliable maps; arrangements have quite recently been made with the Local Government by which it is hoped new maps of the Punjab will be gradually produced; at present the scheme is in its infancy, but I trust it will shortly be organised on a proper footing, with a strong drawing office.

"In Sind a topographical party is at work and should complete the province in nine or ten years, it will then take up the survey of 18,000 square miles yet unsurveyed in Rájputána.

"There are hilly portions of Madras of which we have no maps worthy of the name. A topographical party was provided for the survey of these on the 1 inch scale, but it was directed to take up the special surveys of the forest reserves, on the scale of 4 inches to the mile, and of course its progress, though it is a double party, is slow. There are upwards of 26,000 square miles in this Presidency still to be topographically surveyed.

"It is difficult to say what area still remains for survey in Burma, the Lushai Hills, Hill Tippera and the Chittagong Hill Tracts, but it cannot be less than 150,000 square miles, which will occupy the present parties for some 15 years.

"The above are in British Territory or Tributary States, but besides those we have 80,000 square miles in Hyderabad of which we have maps formed from rough

reconnaissances; and a very large area in the eastern Himálayas, including Nepál of which we know but little more than can be gathered from native information.

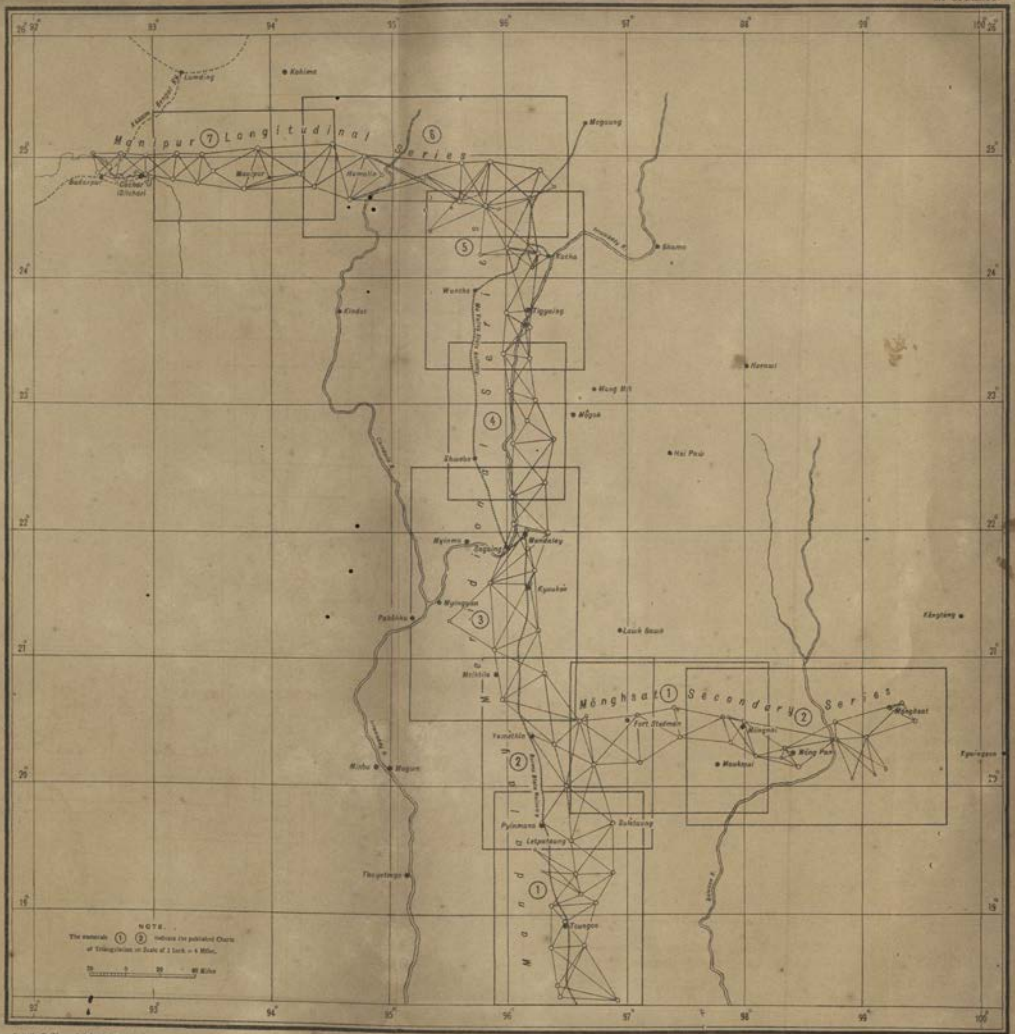
"Without pretending that the above embodies all that remains to complete the first survey of India or that the figures quoted are more than approximate, I think I have shown that there is work enough to employ the topographical branch for many years to come, without taking into account resurveys on a larger scale which will assuredly be hereafter required in special places.

"The future of the cadastral surveys has been or will be provided for provincially; they can never end, as the fields and other details are constantly changing, and in many cases resurveys will be necessary when new settlements are required.

"In the scientific branch there is still a large amount of work to be done. Owing to the extension of our surveys and reconnaissances to the west and north-west in Balúchistán and Persia, and to the east and north-east in Burma, it has been found absolutely necessary to extend the principal triangulation; in Burma several base lines will have to be measured, and probably some telegraphic determinations of longitude will be desirable. The observations for latitude and azimuth, which have been constantly put aside for other more urgent work, have yet to be finished in India and they must be made in Burma also. The magnetic survey has not yet been even commenced. The observations at many of the tidal stations will not be completed for several years, and the levelling operations are still going on in India, whilst Burma has only one line of levels—that from Elephant Point to Mandalay."

INDEX TO THE CHARTS OF THE PRINCIPAL TRIANGULATION
OF THE
MANDALAY MERIDIONAL AND MANIPUR LONGITUDINAL SERIES.

No. 24 PARTY.



Reg. No. D. 411. S. I. D. - Dec. 98-100

Photozincographed at the Office of the Trigonometrical Branch, Survey of India, Dehra Dun.

NO. 7-S. 00.

PART II.

THE OPERATIONS OF THE SEVERAL FIELD PARTIES.

TRIGONOMETRICAL SURVEYS.

INDIA TRIANGULATION.

No. 24 PARTY.

57. This party under Captain Fraser, R. E., started from Calcutta on the 14th October, arriving in Rangoon on the 17th October and in Mandalay on the 19th October.

Personnel.

Captain H. A. D. Fraser, R.E., Officiating Deputy Superintendent, 1st grade, in charge from 14th October 1898 to 12th May 1899.

Lieutenant H. H. Turner, R.E., Officiating Deputy Superintendent, 2nd grade, in charge from 1st to 13th October 1898, from 13th May to 28th June 1899, and from 22nd August to 30th September 1899.

Mr. J. Hickie, Extra Assistant Superintendent, 4th grade, in charge from 29th June to 21st August 1899.

Mr. D. J. Hunter, B.A. } Sub-Assistant Superintendents, 3rd grade. Joined the party on 1st October 1898.
" H. R. Hunter }

58. After a halt of two days the whole party embarked on board, one of the Irrawaddy Flotilla Company's boats, and proceeded down the river as far as Pakôk-ku, where the party changed into the Chindwin steamers. The journey up the Chindwin occupied 7 days, and Homalin was not reached until the 30th October 1898.

59. A halt of seven days was made at Homalin, the time being employed in adjusting instruments and lamps.

60. Actual work was commenced by Captain Fraser at Tonsakah on the 12th November, the idea for the season's work being to connect up the India and Burma triangulations. Great difficulty had been experienced by Captain Fraser in 1895-96 in observing across the Chindwin Valley. These difficulties had led him to consider whether the lamps could not be considerably improved, with the result that the party took the field with not only a very much improved lamp but they also had with them a stock of acetylene, some of the lamps having had special fittings made to allow of either acetylene gas or Duplex oil lamps being used in them. The lamps had previously been thoroughly tested by being observed at Roorkee from Mussooree.

61. As a result of the improved lamps very little difficulty was experienced in observing across the Chindwin Valley, and the great quadrilateral was finished by the 17th December, acetylene gas being used for all the longer rays. The longest of these rays was 61·4 miles.

62. Owing to bad weather being experienced the season's work was not completed until the 19th of March 1899. In addition to joining on to Captain Burn's work of 1894-95, several of his angles were re-observed, in order that it might be ascertained whether the great earthquake of 1897 had caused any movement of the earth's crust in this neighbourhood. The result of these observations given below, tended to prove that there had been no movement whatsoever.

Comparison table showing the angles observed at Kaupru, H. S., Loijing, H. S., and Pangkibot, H. S., during the seasons 1894-95 and 1898-99.

Angle between Stations.	Observed by		
	Captain Burn, R.E. 1894-95.	Captain Fraser, R.E. 1898-99.	Lieutenant Turner, R.E. 1898-99.
At Kaupru, H. S.	° ′ ″	° ′ ″	° ′ ″
Loijing, H. S. and Pangkibot H. S.	41 5 50·18	41 5 50·60	

Comparison table showing the angles observed at Kaupru, H. S., Loijing, H. S., and Pangkibot, H. S., during the seasons 1894-95 and 1898-99—contd.

Angle between Stations.	Observed by								
	Captain Burn, R.E. 1894-95.			Captain Fraser, R.E. 1898-99.			Lieutenant Turner, R.E. 1898-99.		
At Loijing, H. S.	°	′	″	°	′	″	°	′	″
Khaojing, H. S. and Pangkibot H.S.	25	19	56·91				25	19	56·71
Pangkibot, H. S. and Kaupru, H. S.	81	26	20·57				81	26	20·78
Kaupru, H. S. and Maphitel, H. S.	53	38	29·41				53	38	29·25
Maphitel, H. S. and Khambiching	11	16	19·54				11	16	19·25
At Pangkibot, H. S.									
Kaupru, H. S. and Loijing, H. S.	57	27	52·48				57	27	52·01

63. Two observers (Captain Fraser and Lieutenant Turner) were working throughout the season; it was considered better for both observers to start work from the Burma side.

64. Captain Fraser observed at Tonsakah, Thyoliching, Sirohifurar, and Kaupru and re-observed the angles at Khambiching; Lieutenant Turner observed at Tamunja, Khambiching, Maphitel, and Loijing and one angle at Pangkibot. Owing to both observers working from the same side, there was occasionally a delay in waiting till the one had finished observations at one station, before the other could commence at the other end of the ray; a far greater cause of delay was the bad weather and thick haze, but fortunately the work required to be done was satisfactorily finished.

65. The season is a memorable one from the fact of the Burma triangulation being linked up with the Indian, the result being on the whole satisfactory.

In computing out the results the values obtained from the Burma side were carried on to the side Ramphan, H. S.—Tukbai H. S. of the Cachar Branch Series, the two figures of Captain Burn's work of 1894-95 being recomputed.

66. The instruments used were No. 2 and No. 3 Troughton and Simms 12-inch Micrometer Theodolites.

67. The method of observing was to measure angles on twelve zeros, two faces on each zero, and at least two swings on each face.

Towards the end of the season the body of the instrument was shifted through 120° at every 4th zero, in order to bring the female portion of the cone bearing, into different positions with reference to the zero station. The shifting was effected by lifting the instrument bodily from its stand and in replacing it; each footscrew was brought over a different leg.

No. 3 proved itself to be a very high class instrument, but No. 2, as in former years, proved very unreliable, and gave indifferent results.

68. The season's outturn of work is as follows:—

Number of stations newly fixed	5
Do. figures completed	3
Length of series completed in miles	111
Area of triangulation in square miles	2,540

The mean triangular error in seconds was 0·64. This rather large error was due to the unreliable results given by No. 2 Theodolite.

69. The health of the party during the first-half of the field season was not good owing to the feverishness of the districts in which the work had to be carried on, but later the general health decidedly improved, though a few men had to be sent back to their homes early.

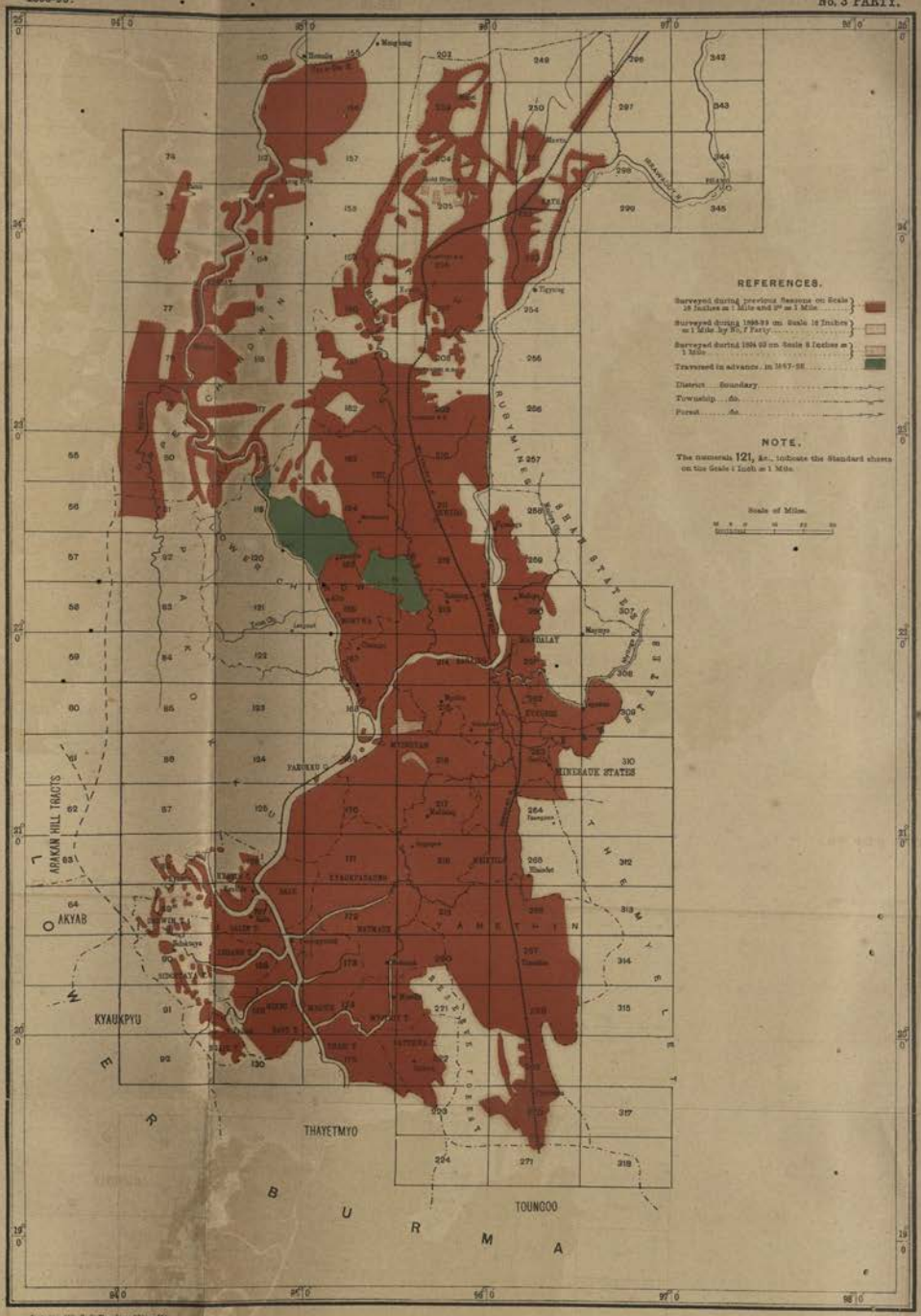
70. The work was greatly facilitated by the kindness of the Political Agent of Manipur, and the Deputy Superintendent, Upper Chindwin, in rendering the Party every assistance on all possible occasions.

The officer in charge is well pleased with the work of his assistants.

BURMA SURVEY.

INDEX TO THE CADASTRAL SURVEY IN UPPER BURMA.

1898-99. No. 3 PARTY.


REFERENCES.
Surveyed during previous Seasons on Scale 16 Inches or 1 Mile and 4ft or 1 Mile
Surveyed during 1898-99 on Scale 16 Inches or 1 Mile by No. 3 Party
Surveyed during 1898-99 on Scale 8 Inches or 1 Mile
Traversed in advance, in 1897-98
District Boundary
Township do.
Forest do.
NOTE.
The numerals 121, &c., indicate the Standard sheets on the Scale 1 Inch or 1 Mile.
Scale of Miles.
ARAKAN HILL TRACTS
AKYAB
KYAUKPYU
THAYETMYO
TOUNGOO
KINGDOM OF BURMA
SHAN STATES
MANDALAY
PEGU
TENASSERIM

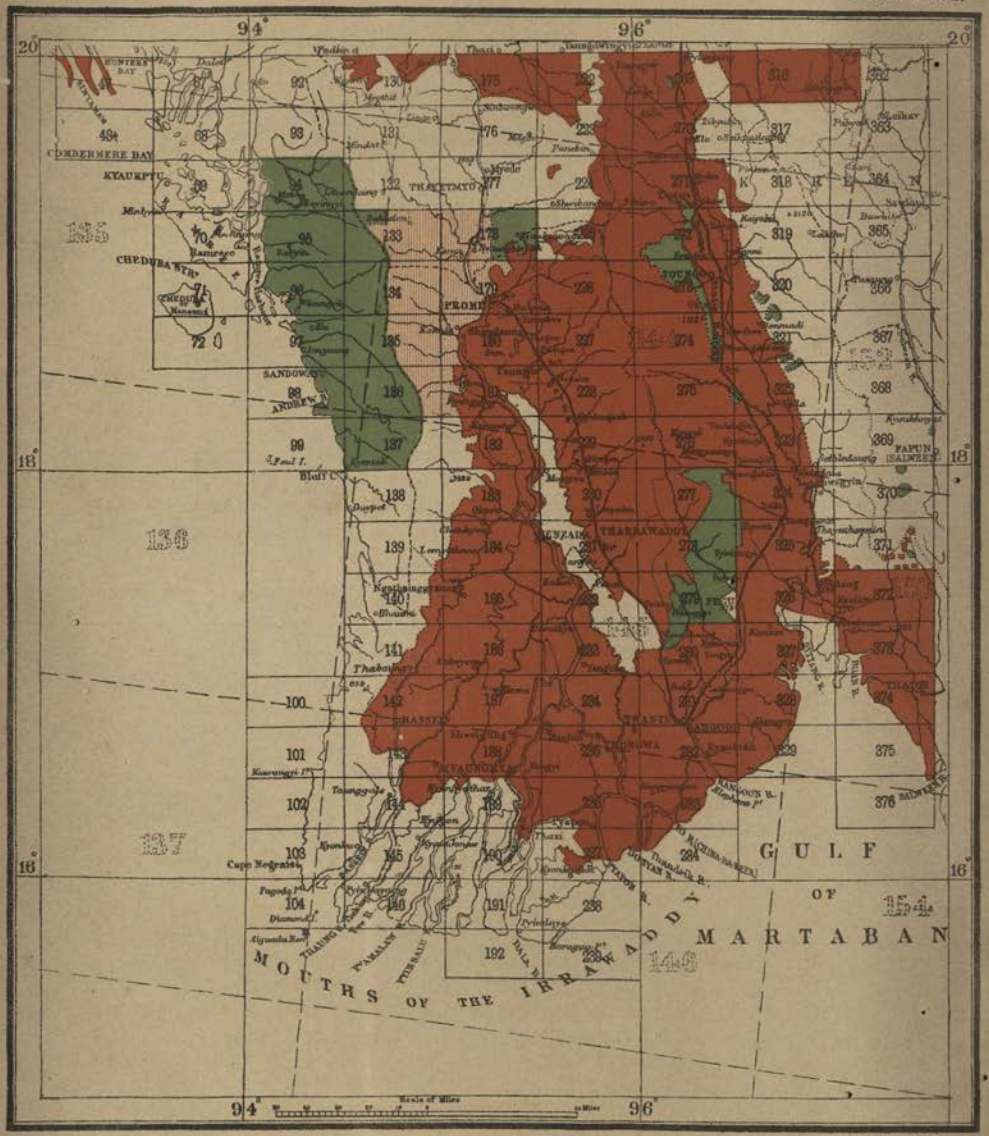
Eng. No. 339, S. Z. D.—Jan. 1900—950.

Photo. S. I. O., Calcutta.

No. 412-S. 1900.

INDEX TO THE TOPOGRAPHICAL SURVEY IN LOWER BURMA.

1898-99. No. 3 PARTY.



NOTE.

The numerals 180, &c., indicate the Standard sheets on the Scale of 1 Inch = 1 Mile.

The names of Cities Surveyed on large Scale are underlined thus RANGOON

The figures and lines in strokes represent the numbers & limits of the Engraved sheets of the Indian Atlas.

Photo. S. I. D., Calcutta.

REFERENCES.

Area Surveyed by Forest & Cadastral Parties on 1, 2, 4 & 16 – Inch Scales.....

.....Do.....during 1898-99 by No. 3 Party.....

.....Do.....Triangulated, & Traversed in advance.....

Reg. No. 601, S. I. D. – Mar. 01 – 500.

No. 436-S. 00.

LOWER BURMA.

NO. 3 PARTY.

71. On the 15th November 1898 Mr. T. E. M. Claudius made over charge of No. 7 Party (Cadastral) at Rangoon to Mr. E. J. Jackson, and on the following day assumed charge of No. 3 Party. In this capacity he remained till the 15th September 1899, when he was relieved by Mr. E. Litchfield, and received orders to proceed to Dehra Dún to take charge of No. 20 Party, Burma Forest Surveys. On the 20th April Mr. G. C. Swiney was transferred to No. 7 Party (Cadastral).

Personnel.

Mr. T. E. M. Claudius, Extra Assistant Superintendent, 1st grade, in charge.
Mr. G. C. Swiney, Extra Assistant Superintendent, 5th grade.
„ C. George, ditto, 6th „
„ M. Gastaud, ditto, 6th „
„ J. Donaghey, Sub-Assistant Superintendent, 2nd „
„ E. H. Corridon, ditto, 3rd „
Sub-Surveyors Asmatulla Khan, Nizamudin, Rohan Lall, Ram Sarup and sixteen others.

72. As No. 3 Party (Cadastral) was converted into a topographical one, assistants and surveyors accustomed to that style of work were posted to it from various parties. All assembled at Prome by the 15th November, and by the 25th idem had left for their respective ground of work. On the 10th May all the members reached recess quarters at Bangalore, with the exception of the triangulators, who did not return till the middle of June.

73. The plane-tabling portion of the party was divided into two sections, the northern and the southern. Each consisted of nine plane tablers. The former was supervised directly by Mr. Claudius with Mr. Swiney's occasional assistance; and the southern was solely under Mr. George's supervision. Mr. Swiney supervised the traverse work in the Pegu district, whilst Mr. M. Gastaud and Sub-Surveyor Ram Sarup were deputed for triangulation in advance in the Sandoway and Kyaukpyu districts.

74. The programme for the field season was the survey in detail on the 1-inch scale of the ground lying between the crest of the Arakan Yomas and the river Irrawaddy and between the parallels of 18° 15′ and 19° 15′, including parts of the districts of Prome, Thayetmyo, and Henzada. A portion of detail work was also done on the left bank of the Irrawaddy in standard sheets 178 and 179. The triangulation was undertaken of the country between the sea coast and the Yomas, between the parallels of 18° 0′ and 19° 30′, and traverse work in the unfinished portions of sheets 278, 279, and 280 in the Pegu district. The whole programme was successfully accomplished.

75. The outturn of detail work on the 1-inch scale was 1,963 square miles. The triangulation comprised 3,512 square miles, and the traverse work consisted of 185 linear miles, a most creditable result, seeing that this is the first field season of the party as a topographical one.

76. The cost rates are as follow:—

	R a. p.	
Detail survey, 1-inch scale	28 12 1	per square mile.
Triangulation	5 0 11	„ „

77. In the country under survey the Arakan Yomas attain an altitude of from 3,000 to 3,800 feet, whilst the lower hills range from 300 to 2,000 feet. The inhabited area is confined to the plains, in the vicinity of the Irrawaddy river on the east of the Yomas, and the sea coast on the west. The remaining area, about two-thirds of the whole, is uninhabited and hilly, covered with dense forest, and infested with wild elephants, rhinoceri, tigers, bison, etc., etc. There are only three roads practicable for carts, one about 10 miles in length leading from Sandoway to Gaw on the sea coast, another about 4 miles long from Sandoway northwards. The third is a military road connecting Prome on the Irrawaddy with Taungup on the sea coast. After passing the large village of Padaung, it crosses the Yomas. Rest-houses exist along this road about 8 to 10 miles apart. There is telegraphic communication between Prome and Taungup, but none between the latter place and Sandoway. Taungup is, however, connected with Kyaukpyu. In the forests the surveyors moved about principally along wild elephant tracks, which were fairly numerous. The

inhabitants were mostly Burmans in the plains, but in the hilly tracts a few Chins were met with.

78. As was expected in such unhealthy ground, a good deal of sickness was experienced, mostly fever and dysentery. Of fifteen serious cases among the *khalásis*, three proved fatal. After returning to recess Sub-Sulveyor Nizamudin, an able and experienced topographer, died from malarious fever contracted in the Yomas; and Sub-Surveyor Asmatulla Khan has been entirely prostrated from the same cause. Of the European assistants Mr. Corridon suffered most. His constitution appeared to be quite shattered when he reached recess quarters in May. The delightful climate of Bangalore has, on the whole, re-established the health of all the members.

79. The party was inspected by the Deputy Surveyor-General, Revenue Branch, in the field in January, and in recess quarters at Bangalore in August.

The Surveyor-General also visited and scrutinized the work and office in September.*

UPPER BURMA.

NO. 10 PARTY.

80. Lieutenant W. M. Coldstream, R.E., continued to hold charge of this party up to the 28th October 1898, when he was invalided home; the direction then devolved on Captain F. W. Pirrie, I. S. C., who remained in charge of the party up to the 31st May. He then left for England on a year's furlough, handing over temporary charge of the party to Mr. G. D. Cusson.

Personnel.

Lieutenant W. M. Coldstream, R. E., Officiating Deputy Superintendent, 2nd grade, in charge from 1st to 28th October 1898.
Captain F. W. Pirrie, I.S.C., Officiating Deputy Superintendent, 2nd grade, in charge from 29th October 1898 to 31st May 1899.
Mr. G. D. Cusson, Extra Assistant Superintendent, 4th grade, in temporary charge from 1st June 1899.
Mr. G T. Hall, Extra Assistant Superintendent, 5th grade, up to 14th October 1898.
Mr. P. J. Serrao, Sub-Assistant Superintendent, 1st grade.
„ C. C. Byrne, Sub-Assistant Superintendent, 3rd grade.
„ W. G. Jarbo, Sub-Assistant Superintendent, 3rd grade.
18 Sub-Surveyors and Apprentices.
1 Writer and 1 Hospital Assistant.

81. The party left recess quarters at Bangalore on the 3rd of November, arriving at Mandalay on the 9th, and leaving again for its ground on the 21st idem. During the passage from Madras to Rangoon one of the apprentice Sub-Surveyors died of fever.

82. Captain Pirrie proceeded three times during the field season to Bhamo for longitude operations with Captain Ryder, R.E., between Bhamo and various points in Yunnan; and the results obtained were highly satisfactory.

83. Mr. G. D. Cusson with Messrs. C. C. Byrne and W. G. Jarbo, seven Sub-Surveyors and six apprentices, took up the one inch detail survey of sheets 261, 262, 263, 264, 265, 266, 267, 312, and 313.

84. Mr. P. J. Serrao triangulated in sheets 254, 255, 256, and also fixed points in sheets 253, 301, 302, and 303. On his return to Mandalay, he with four Sub-Surveyors was employed on detail survey in the western portions of sheets 265 and 267. In addition to the above, sheets Nos. 267 and 268 were triangulated in by an Assistant and a Sub-Surveyor.

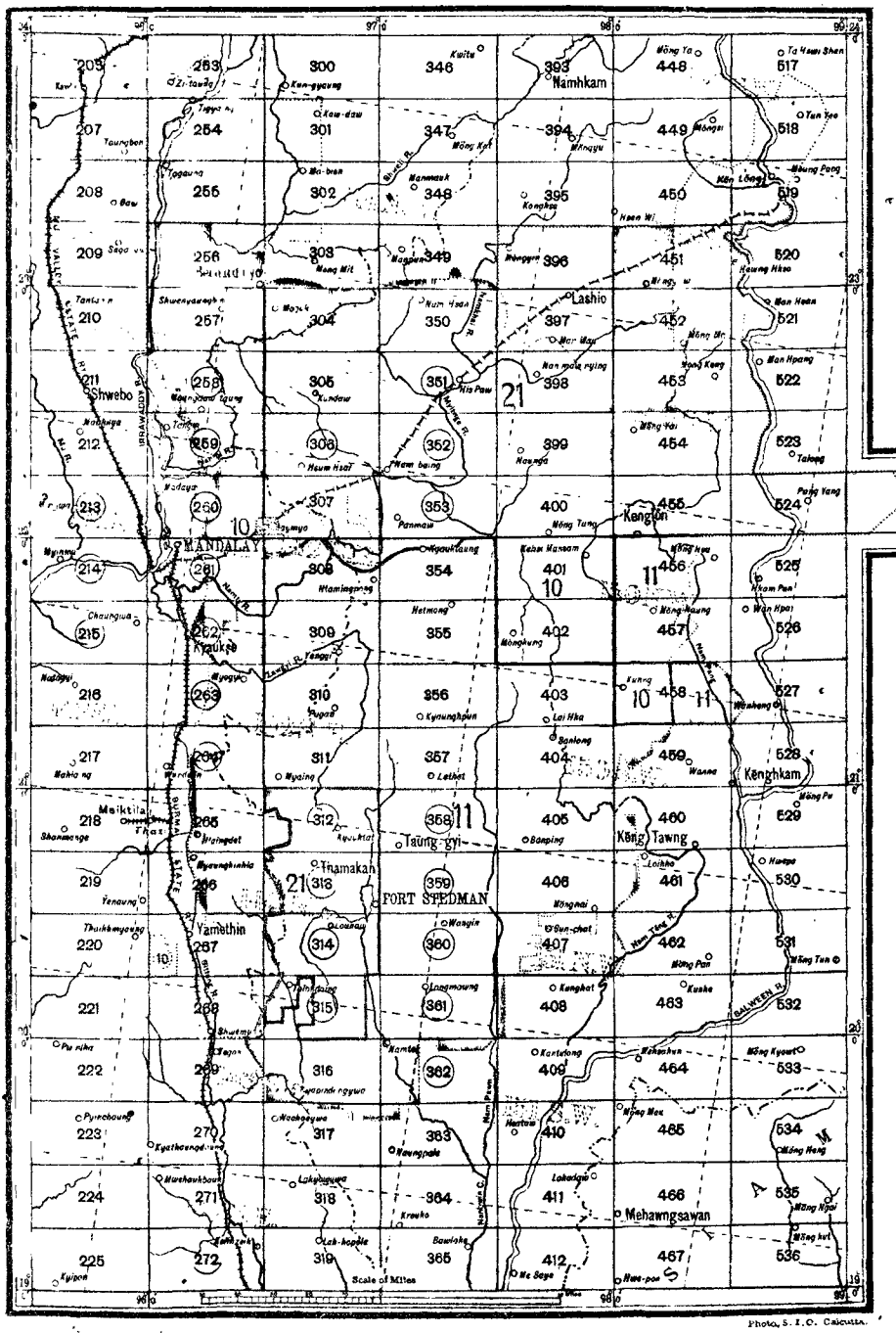
85. The Maymyo survey, comprising an area of 25·3 square miles, on the scale of 16 inches to a mile, having the *bazar* in the centre, was traversed by No. 7 Party; and the detail survey, which was started by a detachment of the same party, consisting of one *Inspector* and two *Amins*, was taken over by No. 10 Party from 1st December 1898. The cadastral survey was completed on 8th April 1899; and about seven of the sheets were contoured before the end of the field season. The method employed was that of traversing along each 50 feet contour, using the clinometer as a level; the initial points being given by Mr. C. C. Byrne from observations with a theodolite to three trigonometrical stations. A ten and a twenty-foot bamboo could sometimes be used with success in filling

* Mr. Claudius reports very favourably of the services of Mr. George, who, throughout the year, has worked cheerfully and indefatigably. Messrs. Gastaud and Corridon have also given entire satisfaction. Of the Sub-Surveyors special mention is made of the good work turned out by Asmatulla Khan, Nizamudin, Mohamed Khan II, and Mulk Raj. Sub-Surveyor Ram Sarup has proved himself to be an exceptionally good triangulator. Writer Nisarali is reported a being quite competent in all his duties.

UPPER BURMA SURVEY.

INDEX TO THE TOPOGRAPHICAL SURVEY IN UPPER BURMA & SHAN STATES.

1898-99. Nos. 10, 11, & 21 PARTIES.



Photo, S. I. C. Calcutta.

No. 445-S. 00.

REFERENCES

(352)

NOTES.

The numerals 312, [illegible] indicate the Standard sheets on the Scale [illegible] Mile.

The figures and lines in strokes represent the numbers [illegible] Engraved sheets in the Indian Atlas.

The thick lines represent the [illegible] by the different Topol. Parties, the large figures indicating the number of the Party.

in the intermediate 10 feet contours, when working down hill. Also Colonel Wahab's height indicator was often used and did a great deal to accelerate the work. The Maymyo topographical detachment was under the charge of Mr. C. C. Byrne, after the work was started by Captain Pirrie.

86. The outturn for the season is as follows :—

	Square miles.
Triangulation for detail survey	2,798
Topography, one inch scale, including 276 miles overlap .	2,338
Maymyo survey, scale 16 inches to 1 mile	8

This outturn is an improvement both in quantity and quality, compared with the previous season's work, and is very creditable considering that the party lost a Sub-Surveyor through death just before the beginning of the field season, and another by transfer in January.

87. The health of the party was, on the whole, excellent throughout. One of the triangulators in sheet 267 suffered from fever, and a Sub-Surveyor died of debility in hospital after the close of the field season.

88. The whole party, except the Maymyo detachment, left for Bangalore on the 18th May, and arrived there on the 25th ; the recess office being opened there on the 29th. The above detachment left Mandalay on the 15th of June and arrived at Bangalore on the 22nd.

89. During the recess the computations have been brought up to date ; and sheets Nos. 461, 463, 464, 465, 466, and 467, have been prepared for publication in two colours. Sheets 312 and 313 have also been completed in the same style as the portions already published. Sheets 1 and 4 of the Maymyo survey have been prepared for publication ; and the outlining of sheets 2, 5, 7 and 8 completed.

90. The total cost of the party for the year was R86,135-2-4, and the cost rates per square mile are :—

	R	*a.*	*p.*
For triangulation	9	13	2
„ topography	19	15	9

These figures compare favourably with those of last year, the rates being less both for triangulation and topography.

91. The programme for next season is :—

The triangulation of sheets Nos. 268, 221, 220 and 219 ; the unsurveyed gaps in 210, 211, 212 and 213, and a network to connect the gaps falling in sheets Nos. 170, 171, 217, 218. In detail survey the completion of the large scale survey of Maymyo, and the one inch survey of sheets 257, 258, and 268, and the completion of sheets 259, 260, 261, 262, 263, 264, 265, 266, and 267.*

UPPER BURMA.

No. 11 Party.

92. The services of Captain Renny-Tailyour, R.E., being again required for the Burma-China Boundary Commission, Mr. P. J. W. Doran continued in charge of the party.

Personnel.

Mr. P. J. W. Doran, Extra Assistant Superintendent, 4th grade, in charge.
Mr. W. M. Kelly, Extra Assistant Superintendent, 5th grade
Mr. P. White, Extra Assistant Superintendent, 6th grade.
Mr. H. G. Shaw, Sub-Assistant Superintendent, 1st grade.
Mr. B. M. Berrill, Sub-Assistant Superintendent, 3rd grade.
Surveyor J. Sebastian and 12 Sub-Surveyors and Probationary Sub-Surveyors.
1 Writer.
1 Typer.

93. In addition to the surveyors transferred from the party during the previous year, there was a further reduction by the transfer of Surveyor Ram Sabad to the Yunnan Mission and of Sub-Surveyors Kudratulla and Mowni Ram to the Burma-China Boundary Commission.

Mr. Berrill, Sub-Assistant Superintendent, 3rd grade, joined the party at Rangoon from the Dehra Training School, on the 8th of November 1898.

Mr. White unfortunately falling ill was unable to cope with the work allotted him and returned to head-quarters on the 5th of May. He has been invalided and pensioned from the 7th of July 1899.

* The officer in charge reports that Messrs. P. J. Serrao and C. C. Byrne deserve special mention for the excellence of their work ; and among the Sub-Surveyors, Sakhawat Husain, Syed Ali Shah, Sheikh Abdulla, and Radha Krishen.

94. The party, with the exception of Mr. White, who had started a week earlier, left Bangalore, the recess quarters, on the 2nd of November 1898, sailed from Madras on the 3rd and reached Lawk Sawk, in the Southern Shan States, its head-quarters for the field season, on the 8th of December. Field work was commenced on the 7th of December and closed on the 18th of May 1899. The party, with the exception of Mr. White and Sadiq Hossein, returned by the steamer leaving Rangoon on the 2nd of June, and office opened at Bangalore on the 12th.

95. The programme for the season was the detail survey of sheets Nos. 310, 311, and 357, sheet No. 356 was also to be taken up, if possible. The triangulation to be taken up was that of sheets Nos. 308, 309, 354, 355, 356, 456, and 457 as "triangulation in advance."

Detail Survey.—The programme was completed, sheet No. 356 was not only planetabled but also triangulated.

Triangulation.—The sheets laid down for triangulation in advance were all completed except Nos. 456 and 457, of which only 250 square miles could be finished.

96. The outturn of work is as follows :—

(*a*) Detail survey on 1 inch scale, 2,524 square miles, inclusive of an overlap of 306 square miles.

(*b*) Triangulation, 3,234 square miles, inclusive of an overlap of 220 square miles.

The area surveyed, considering the nature of the ground and the reduction in the strength of the party, is very creditable.

97. The total cost of the party is ₹81,093-5-10.

The cost-rate, as noted below, compares favourably with the rates of previous season. Triangulation for 1 inch survey, ₹11-6-4. Detail survey on 1 inch scale, ₹17-8-0.

98. The health of the party during the field season was good. At the beginning and particularly at the close there were several cases of fever among the natives. During the recess, the malaria contracted in Burma has shown itself among the surveyors and *khalásis*.

99. The detail surveyors were visited regularly during the season. The work after a rigorous test proved excellent.

100. The programme for the coming season will be the survey in detail of sheets Nos. 308, 309 and the western halves of sheets Nos. 354 and 355, and the triangulation of sheets Nos. 525 to 528 and the portions of 456 and 457 left unfinished during the season under report.

101. The Surveyor-General visited the party on the 19th of September, and after a careful examination into the working, expressed himself as "very well satisfied."*

UPPER BURMA.

No. 21 Party.

102. The Party left recess quarters at Bangalore on 2nd November 1898, and proceeded to Lashio in the Northern Shan States, where the head-quarters were established, and returned to recess quarters on 18th May 1899, regular office being opened from 25th idem.

Personnel.

Captain C. H. D. Ryder, R.E., Officiating Deputy Superintendent, 1st grade.*
„ H. J. Hare, R.E., „ „ „ 1st „ †
Mr. A. J. James, Extra Assistant Superintendent, 2nd grade.
„ W. F. E. Adams, Sub-Assistant Superintendent, 1st grade.
„ A. H. Peychers, „ „ 2nd „ Died 20th February 1899.
„ P. Williams, Sub-Assistant Superintendent, 3rd grade.
„ P. R. Anderson, „ „ 3rd „
Munshi Ikbaluddin, „ „ 3rd „ †

Surveyors and Sub-Surveyors.

Lachman Jadu,* Ram Sabad,* Ganu Mal, Natha Singh,‡ Mohamed Latif,§ Kudrat Ali, Jamna Pershad, Keshao Jadu,‡ Abdul Gaffur, Hazrat Ali, Permanand, Shamsuddin, and 4 Probationary and Apprentice Sub-Surveyors.

* Attached to Yunnan Survey throughout the season.
† „ to Burma-China Boundary Commission throughout the season.
‡ „ to Yunnan Railway Survey throughout the season.
§ „ to Pekin Syndicate.

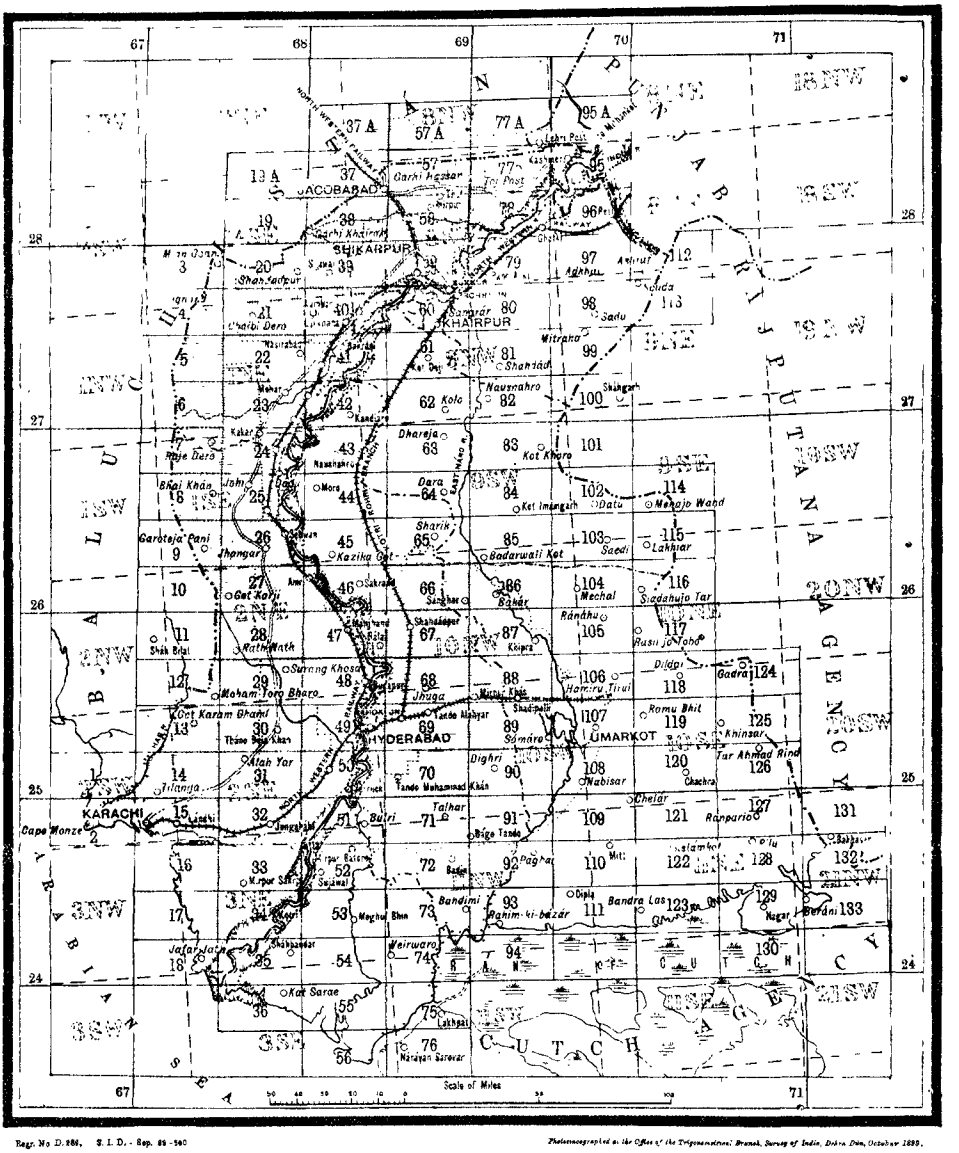
103. Owing to the exigencies of

* The officer in charge reports in high terms of the work done by Messrs. W. M. Kelly, H. G. Shaw, and B. M. Berrill.
The surveyors and sub-surveyors with one exception have worked well.

1898-99.

SIND SURVEY.

Nos. 12 and 15 PARTIES



Regr. No. D. 886, S. I. D. - Sep. 98 - 500

Photozincographed at the Office of the Trigonometrical Branch, Survey of India, Dehra Dún, October 1899.

REFERENCES.

Surveyed in previous Seasons Scale 1" = 1 Mile by No. 12 Party.

Do. do. do. 2" = 1 Mile do.

Do. 1898-99 2" = 1 Mile do.

Triangulated and Traversed in advance do.

Surveyed in previous Seasons Scale 1" = 1 Mile by No. 15 Party.

Do. 1898-99 1" = 1 Mile do.

Triangulated in advance do.

Indus Riverain Survey

NOTES.

The numerals 63, etc., indicate the Standard sheets on the Scale 1 Inch = 4 Miles.

The figures and lines in succes represent the numbers and limits of the Registered sheets of the Indian Atlas

NO. 252-S. 99.

the Burma-China Boundary Commission the working strength of this party was considerably reduced during the field season, with the natural result that the outturn of work was considerably below that of a normal season.

The detail survey of sheets 396 and 397, with a small gap remaining in sheet 350, on the scale of 1 inch=1 mile, was completed.

The triangulation in advance for 1 inch survey was carried out in parts of sheets 450, 451, 452, and 453; over the whole of 454, 455, and 524, and in parts of 518, 519, 520, 522, and 523.

The outturn of work is as follows: Triangulation for the 1 inch survey 3,416 square miles, Topography on the 1 inch scale 1,133·5 square miles, Topography on the ½ inch scale in Yunnan 26,850 square miles. The total cost of the party from 1st October 1898 to 30th September 1899, is ₹92,724-9-4, and the cost rates per square mile are as follows :—

	Per square mile. ₹ a. p.
Triangulation for 1 inch survey	11 9 8
Detail Survey 1 inch scale	11 12 3
„ ½ inch „	1 8 0

which figures are as low as could be expected under the conditions of the smaller outturn.

104. A very regrettable incident occurred during the course of the field season, Mr. A. H. Peychers, Sub-Assistant Superintendent, having been murdered in cold blood by a sepoy of his escort, while at work on 20th February at Loi Hopong Hill Station. Mr. Peychers was a promising lad and his untimely death is much regretted. The murderer was duly tried and executed.

105. The health of the party, with a few exceptions, was uniformly good throughout the season, and no deaths occurred from sickness.

106. The country surveyed included parts of the Hsi Paw, and the Northern and Southern Hsinwi States. The ground is all very hilly and covered with heavy tree and scrub jungle. About four miles to the north of Lashio there are hot sulphur springs, more or less in the shape of a horse-shoe; the waters of which have the reputation of possessing healing properties for curing certain diseases if regularly bathed in for some time. The Shans of the country, as well as Natives of India living round about Lashio, make free use of them.

107. The Surveyor-General inspected the party on the 20th September 1899, and was generally satisfied with what he saw of maps, records, etc., of the party during his inspection.*

SIND.

No. 12 Party.

108. The operations during the year under report were in continuation of those of the previous season. Mr. C. F. Erskine held charge of the party up to the 13th July 1899 when he proceeded on three months' privilege leave making over the temporary charge to Mr. J. A. Barker.

Personnel.

Mr. C. F. Erskine, Deputy Superintendent, 1st grade, in charge from 1st October 1898 to 13th July 1899.
Mr. J. A. Barker, Extra Assistant Superintendent, 4th grade, in charge from 14th July to 30th September 1899.
Mr. G. G. Vander-Beek, Extra Assistant Superintendent, 5th grade.
Mr. R. F. Warwick, Extra Assistant Superintendent, 6th grade.
Munshi Rahmatullah, Sub-Assistant Superintendent, 2nd grade.
Mr. E. C. J. Bond, Sub-Assistant Superintendent, 2nd grade,
Mr. C. J. Veale, Sub-Assistant Superintendent, 3rd grade.
Babu Dhani Ram, Sub-Assistant Superintendent, 3rd grade, and 55 permanent and temporary Sub-Surveyors, Computers and Draftsmen.

109. The programme, which was as follows, was completed :—

(*a*) A short series of secondary triangulation, about 35 miles in length, as a check on traversing, and another short series to supply points.

(*b*) Village boundary traverse survey in sheets Nos. 20, 21, 37, 38, 39, 40, 57, 58, 59, 77 and 78.

(*c*) The detail survey on the 2-inch scale of an area situated between the Indus river on the west, and the desert on the east, in sheets Nos. 70, 71, 90, portions of 50, 51, 91, 108, 109, and 40.

* The officer in charge is perfectly satisfied with the work of all his assistants.

110. The recess office at Karáchi closed on the 17th October 1898, and the party re-assembled at Tando Alahyar on the 20th idem, and each man was on his ground by the end of the month.

111. The traversing consists of a village boundary survey with offsets, and the area traversed is 3,887 square miles. There were 14 main circuits measured, 19 sub-circuits, and 791 village circuits. The angular work was checked by observations for azimuth at 99 stations on main and sub-circuits, and the average angular error is 1′ 34″, the angular error per station being 3″·7. The linear measurements amounted to 4,118 miles, and were checked by 54 connections with principal stations of the Great Indus Series, and with stations of the secondary triangulation executed by Mr. Bond. The average correction per 1,000 links being 1·21 links. No permanent marks were laid down at traverse stations, but the position of the marks used to demarcate the village boundaries have been fixed by offsets wherever possible.

In addition to the village boundary traverse survey 51 bench-marks laid down by the Irrigation and Railway Departments were connected with the traversing, involving observations at 66 stations and 44 linear miles of chain measurement.

112. The cost of the traverse survey amounts to R8·5 per square mile.

113. The area surveyed in detail on the 2-inch scale amounts to 2,813 square miles, giving 61 plane-table sections. It comprises the whole of sheets Nos. 70, 71, 90 and portions of Nos. 50, 51, 91, 108, and 109, and an area of 72 square miles has also been surveyed in standard sheet No. 40. In sheets Nos. 91, 108, and 109 the survey has been carried to the edge of the desert. Sheets Nos. 50 and 51 have been surveyed up to the work of the Indus Riverain Survey. The remainder of these sheets will be surveyed on the 1-inch scale by No. 15 Party. The detail survey was carried out almost entirely by interpolation, and was based mainly on the traversing; it was tested from 1,756 *in situ* fixings, and was done under the direct supervision of the officer in charge and three assistants. The cost of detail survey is R13-1-0 per square mile.

114. The country surveyed during the past season was generally of the same monotonous and uninteresting description as that dealt with during the previous year, the only hilly portion being the southern limit of the Ganj Takkar falling in standard sheet No. 50. In sheets Nos. 50, 51, and 70 the country was fairly well populated and cultivated, except in the north portion of sheet No. 70, where there is a considerable area of uncultivated land; this, however, in the event of sufficient water being available could, to a large extent, be brought under cultivation; in the west portions of sheets Nos. 50 and 51 on the east of the river Indus, there are large tracts of waste lands covered with *Kandu* (*Prosopis spicigera*) and *Lai* (*Tamarix Dicœa*); there are also considerable Forest reserves near the river, the most important being the Huderáni and Mulchand reserves. The greater part of standard sheets Nos. 71 and 91 are fairly well populated and cultivated, with the exception of the south-east corner of sheet No. 91, which is very sparsely populated, the greater portion being waste land covered with a growth of *babul* trees. In sheet No. 90 the southern portion, which is watered from the Nasir Wah, and the eastern portion, watered by the Mithrau Canal, are fairly well populated and watered, a very large percentage of the balance of the sheet being composed of uncultivated land, of which a very large area will be brought under cultivation when the Jamrao Canal, now under construction, is completed. In sheets Nos. 108 and 109, watered chiefly by the Nára river, both the population and cultivation are scanty, and both rapidly decrease journeying eastwards towards the Thar and Párkar desert.

115. There was little or no sickness.

116. Field work closed early in April, and the party returned to Karáchi for recess. During recess the fair mapping of the entire area surveyed in detail on the 2-inch scale was completed, with the exception of the small portion surveyed in sheet No. 40; this sheet will be drawn next year when the survey is completed. The mapping was comprised in 30 quarter sheets, of which three were blank. They were drawn on the 2-inch scale for reduction by photography to one-half, and have all been despatched to the Trigonometrical Branch Office at Dehra Dún for publication. Sheets Nos. 50 and 51 have been drawn as far as surveyed. The remainder of these sheets will be mapped by No. 15 Party. Sheets Nos. 91, 108, and 109 have been mapped as far as they are to be surveyed

1898-99

INDEX TO THE TOPOGL. SURVEY OF THE LUSHAI HILLS.

No. 14 PARTY.

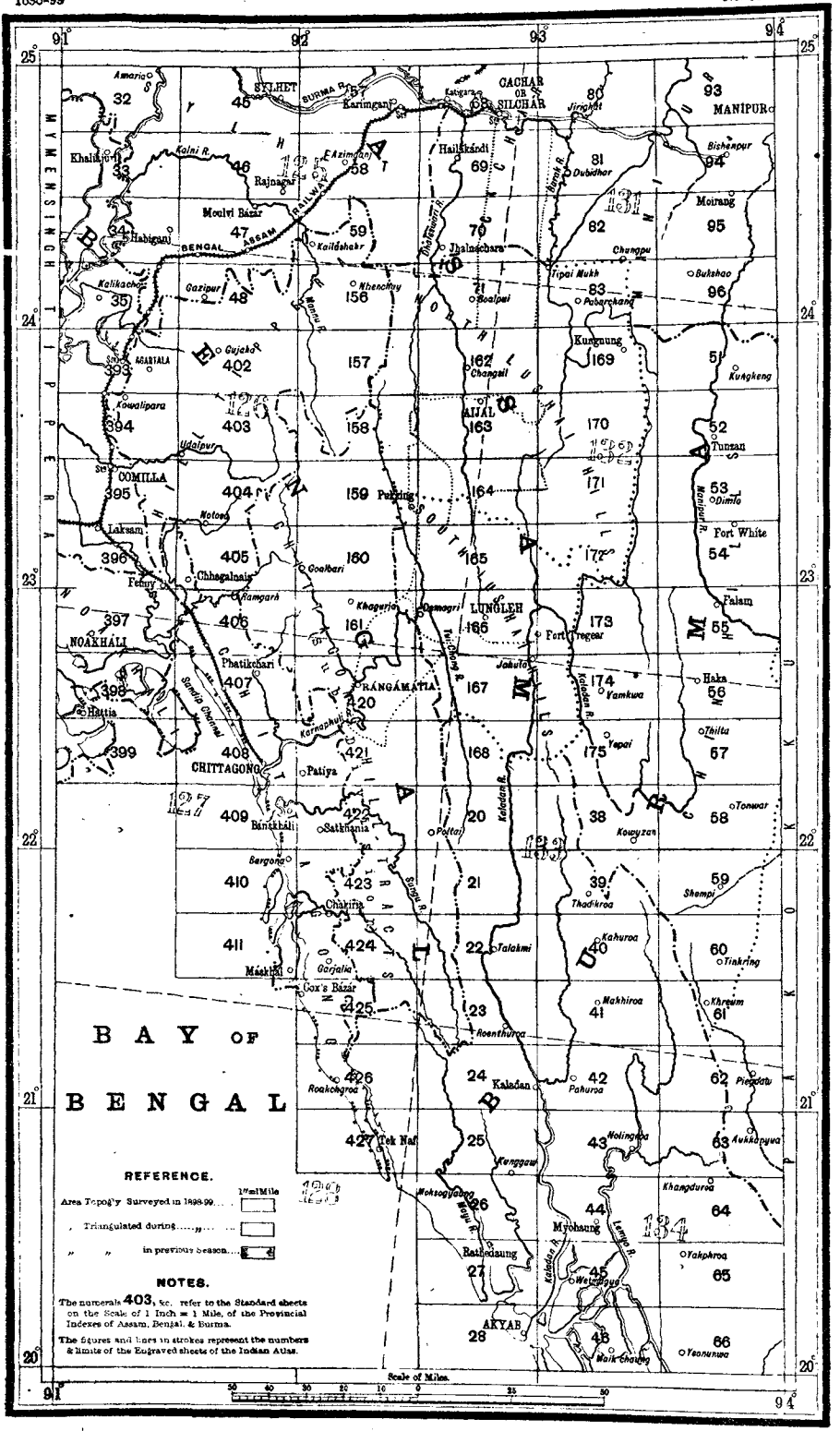


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Photo. S. I. D., Calcutta.

No. 437-S. 00.

at present and will be published. The area surveyed in sheet No. 40 has not been mapped; the detail survey of the remainder of the sheet will be completed during the coming field season, and it will be fair drawn in due course.

117. The triangulation and traverse charts of sheets Nos. 19, 20, 21, 37, 38, 39, 40, 51, 57, 58, 59, and 71 have been drawn. All the charts with the lists of co-ordinates have been despatched to Dehra Dún.

118. Next season triangulation and traversing in advance will be taken up in sheets Nos. 41, 60, 61, 77, 78, 79, 80, 81, 95, 96, 97, 98, 99, and 112.

Detail survey will be carried on in sheets Nos. 19, 20, 21, 37, 38, 39, 40, 57, 58, and 59.*

LUSHAI HILLS, ASSAM.

NO. 14 PARTY.

119. Captain Robertson, on transfer from special duty in Simla, assumed charge from Mr. Keating on the 6th October 1898 and remained in charge till the 29th May 1899, when he again proceeded to Simla on leave and special duty, making over temporary charge to Mr. Keating till the 25th September 1899, when he rejoined the party.

Personnel.

Captain C. L. Robertson, R.E., Deputy Superintendent, 1st grade, in charge from 6th October 1898 to 28th May 1899, inclusive, and from 25th September 1899, inclusive.

Mr. J. Keating, Extra Assistant Superintendent, 6th grade, in charge up to 5th October 1898 and from 29th May 1899 to 24th September 1899, inclusive.

Mr. R. Waller-Senior, Extra Assistant Superintendent, 6th grade.

Sub-Surveyors, etc.

Ram Singh, Mahadeo Daji, Abdul Haq and five others.

120. The party left recess quarters in Shillong on the 16th October 1898, and, with the exception of the assistant detailed to carry out the 1st class secondary series, proceeded to the Lushai Hills *viâ* Goalundo and Silchar. Field work was closed by the 15th April 1899, and the party returned by the same route by which they had taken the field to Shillong, where the office was opened for the recess on the 5th May.

121. The sanctioned programme of work for the season under report, included the completion of the 1st class secondary series commenced during the preceding field season, the extension of a net-work of tertiary triangulation, in continuation of a similar triangulation of the preceding season over standard sheets Nos. 164, 165, and 166, and the execution of a detail topographical survey on the scale of 1 inch = 1 mile of standard sheets Nos. 162 and 163.

The programme of triangulation, with the exception of a small portion of tertiary work on the southern edge of sheet No. 166, has been completed.

The detail topographical survey, however, of only one complete standard sheet (No. 162) has been carried through, though a portion of sheet No. 163 has also been surveyed.

122. Mr. Keating, to whom was entrusted the completion of the 1st class secondary series commenced by him during the preceding season, proceeded with his squad to Chittagong, and starting work from a side of the Burma Coast G. T. series, worked northwards, completing his series by joining on to his previous work.

A net-work of tertiary triangulation, based on the sides of Mr. Keating's series, and in continuation of the previous season's work of the same kind, was carried out in standard sheets Nos. 164, 165, and 166, by two of the native sub-surveyors assisted, for the part of the season when he was not employed on the supervision of the plane-tablers, by Mr. Waller-Senior.

The remainder of the native sub-surveyors were employed on the detail survey on the scale of 1 inch = 1 mile of standard sheet No. 162 and a small portion of sheet No. 163.

123. The failure to complete the programme of topography has been due to an over-estimate of the capacity of the surveyors in a country presenting the difficulties, physical and other, which are encountered in the Lushai Hills. Owing to the absence of any previous experience in this district the programme had to be framed on utterly insufficient data.

* Mr. Erskine reports that all his assistants worked well and specially mentions Mr. Vander-Beek. The Native establishment with one or two exceptions, gave satisfaction. Ram Kinkar Pershad, Ishar Sing, Gormukh Singh, Maula Bakhsh, Mohamed Akbar, and Alay Ahmad II, are deserving of mention.

A survey of Aijal on the scale of 24 inches to the mile was asked for by the Secretary to the Chief Commissioner of Assam in the Public Works Department, and this was commenced during the field season.

The programme for the ensuing field season will include the completion of the net-work of tertiary triangulation in sheet No. 166 and the execution of a similar net-work in sheet No. 170 and half of sheet No. 171 in extension eastward of previous triangulation, the completion of the detail topographical survey of standard sheet No. 163 and the execution of a similar detail survey of half of standard sheet No. 164.

The large scale survey of Aijal will also be taken up and completed.

Besides the foregoing a detachment consisting of one officer and one native surveyor will be detailed to accompany the military expedition operating about the 1st December 1899, against the Mishmi tribes to the north-east of Assam.

124. The outturn for the season was as follows:—

	Square miles.
1st class secondary triangulation	1,050
Tertiary triangulation (net-work)	1,423
Detail topography on the scale of 1 inch = 1 mile	649

And the cost-rates for the different classes of work are as under:—

	Per square mile. ₹ a. p.
1st class secondary triangulation	22 3 6
Tertiary triangulation (net-work)	31 13 4
Detail topography on the scale of 1 inch = 1 mile	64 6 9

As the net-work triangulation of the previous season (1897-98) is that on which the detail 1 inch survey of sheet No. 162 has this year been based, its cost-rate (₹50 per square mile) has been accepted in calculating the final cost-rate of that standard sheet and added to that of the detail survey of the season under report, thereby giving the outturn cost-rate as ₹114-6-9 per square mile exclusive of cost of publication. This rate will probably be considerably reduced in future years. The cost-rate of the 1st class secondary triangulation has not been included in calculating the final cost-rates of the topographical survey as the work is trigonometrical rather than topographical.

125. The health of the party during the field season under report has not been good. Out of a total native establishment of 11 native surveyors and clerks, 131 *khalásis* and 400 *Nepálese coolies*; 3 *khalásis* and 20 *coolies* died, and 4 *khalásis* and 11 *coolies* had to be invalided as permanently broken down in health, giving a proportion of deaths and breaks-down of 7 per cent. on the total number of natives employed in the field. Eighteen *coolies*, however, died of cholera which broke out among them during their journey from the Darjeeling district to Silchar. There were besides a large number of cases of sickness under treatment during the field season. Every care was taken of the health of the men, and the high rate of mortality and sickness can only be attributed to the unhealthiness of the country and the hardship inseparable from service in it.

126. The country surveyed is a difficult one, consisting of a series of densely wooded and very steep parallel ridges rising to a height of from 3,000 to 5,000 feet above sea-level with valleys between them whose elevation is but a few hundred feet above that of the sea.

Beyond the one Government mule road running through the country from north to south and one or two branch roads to police outposts, there are no communications other than native foot-paths, and in the uninhabited tracts of the country, considerable areas of which came under survey this year, not even these exist, and here the surveyors have had to cut tracks for themselves. Transport other than coolie was therefore out of the question, and as local labour was not procurable, the necessary number of men (400 *Nepálese coolies*) was obtained through the Deputy Commissioner, Darjeeling. These men, with the exception of a proportion who were of inferior physique, worked well throughout the field season.

As practically no food supplies are obtainable in the country, the food for the party had to be imported from Silchar. The difficulty of rationing the various squads in the field, very considerably added to the difficulties and cost of survey, and necessitated the establishment of intermediate ration depôts scattered about the country for the supply of such squads as were working more than four or five days' march from Aijal.

The smoke haze which sets in about the middle of February each year, and is due to the custom which obtains in these hills of clearing the forest for cultivation by burning it, was found to be another difficulty to the execution of survey operations, especially triangulation, as it renders the observation of the longer rays, even with the use of luminous signals, an absolute impossibility. Another characteristic custom of this district is that of moving the sites of every village every two or three years, a custom which renders the record of village sites and names on the map of very little permanent value.

Much assistance was rendered throughout the field season by the Superintendent of the Lushai Hills and other officers of the Civil Administration.

127. The party was inspected in recess quarters by Lieutenant-Colonel Hobday, I.S.C., Deputy Surveyor-General, Revenue Branch, at the end of September, and he expressed himself satisfied with the work done.*

NORTH-WESTERN FRONTIER.

No. 15 Party.

128. Colonel R. A. Wahab, R.E., held charge from 1st October 1898 till the 12th July 1899, when he proceeded on privilege leave and was relieved by Lieutenant G. A. Beazeley, R.E.

Personnel.

Colonel R. A. Wahab, C.I.E., R.E., Superintendent, 2nd grade, in charge up to 12th July 1899.
Lieutenant G. A. Beazeley R.E., Officiating Deputy Superintendent, 2nd grade, joined the party on the 29th May, in charge from 12th July till the 9th October 1899.
Mr. E. A. Wainright, Extra Assistant Superintendent, 3rd grade.
„ G. A. Knight, „ „ 5th „
„ G. P. Tate, „ „ 6th „
Yusuf Sharif, Khan Bahadur, Sub-Assistant Superintendent, 1st grade.
Hira Singh, Rai Bahadur, Sub-Assistant Superintendent, 1st grade, died 17th September 1899.
Mr. M. C. Petters, Sub-Assistant Superintendent, 2nd grade.
„ H. C. H. Cooper, „ „ 2nd „
Ahmed Ali Khan, Khan Bahadur, Sub-Assistant Superintendent, 3rd grade.
25 Surveyors, and Sub-Surveyors, etc.

The sudden death of Rai Bahadur Hira Singh at Quetta on the 17th September 1899 has deprived the party of one of its best known members. His excellent service on the Afghán Boundary Commission in 1884—86 gained him promotion to the Provincial Service, and his subsequent services in the North-Western Frontier party, both in military expeditions and in regular work, have fully justified his advancement.

129. The different detachments commenced work on or about the 1st November 1898, the field season terminating on dates varying with the different detachments.

130. The surveys in progress during the previous season in Sind and near Ráwalpindi were continued, and a special survey on the 6-inch scale was made of the coal-bearing area on the Sor range near Quetta. Triangulation for 1-inch survey was continued in Sind.

131. During the summer months a detachment has been employed on ½-inch surveys in Kashmir and Gilghit, and in the Indus Valley near Chilas.

132. During the year the recess quarters of the party were moved from Quetta to Mussooree where the North-Western Frontier Drawing Office, hitherto at Simla, has also been transferred. The two offices have always formed one charge under the superintendence of the officer in charge of No. 15 Party, and the desirability of bringing them into closer connection has been obvious for some time. During the recess the fair drawing of the Sind 1-inch sheets has been continued and revised maps of the Quetta Cantonment Survey on the scale of 16 inches =1 mile have been completed.

* The officer in charge reports highly of the assistants with the party and of the cheerful way in which all members performed their duties under exceptionally trying conditions.
Mr. Keating has shown himself an able triangulator and has administered the party during his (Captain Robertson's) absence to his entire satisfaction. Mr. Waller-Senior is especially mentioned for the energy and zeal he has displayed in carrying out his work, for much of the season, in spite of ill-health from malaria contracted in the country.
Sub-Surveyors Ram Singh, for his net-work triangulation, and Gurjan Singh, for his 1-inch detail topography, are especially mentioned, as also Syed Razi Hasan, the writer of the party, for the painstaking way in which he has performed his duties in office.

133. The total outturn of the party is as follows :—

	Square miles.
Triangulation for 1-inch survey	2,765
" " 12-inch "	21
" " ¼-inch reconnaissance	16,000
Detail Survey on 1-inch scale	1,320
" " 2-inch "	271
" " 6-inch "	187
" " ½-inch "	2,043
Reconnaissance and Survey ¼-inch scale	26,274

134. The programme for the ensuing season includes the extension of 1-inch detail survey in Sind, and the commencement of 12-inch survey at Secunderabad. The ½-inch surveys of Kashmir and the Gilghit Agency, and ¼-inch survey and reconnaissance will also be continued.

135. The health of the party has been excellent throughout the year, and with the exception of Rai Bahadur Hira Singh, who died of heart disease, there have been no casualties.*

HIMALAYAS, PUNJAB.

No. 18 Party.

136. Mr. Pocock held charge of the party from the 1st October to the 4th November when he was relieved by Major Bythell, R.E., who continued in charge up to the 2nd May 1899 when he proceeded on special leave making over the party to Mr. Potter.

Personnel.

Major W. J. Bythell, R.E., Officiating Superintendent, 2nd grade, in charge, from 5th November 1898 to 1st May 1899.
Mr. L. J. Pocock, Extra Deputy Superintendent, 2nd grade, in charge, from 1st October to 4th November 1898.
Mr. C. D. Potter, Extra Assistant Superintendent, 3rd grade, in charge, from 2nd May to 30th September 1899.
Mr. W. Robert, Extra Assistant Superintendent, 5th grade.
" G. E. Parker, " " 5th "
" J. O. Greiff, Sub-Assistant Superintendent, 2nd "
" W. M. Gorman, " " 2nd "
" E. J. Biggie, " " 2nd "
" C. E. C. French, " " 2nd "
23 Sub-Surveyors, one Clerk, and 27 others.

137. The party, as in previous seasons, was divided into detachments noted below, each working in different portions of the Himálayas, in the Kángra and Hoshiárpur districts, and also in the Simla Hill States and in Suket and Sirmúr. The detachments left, and returned to, recess quarters on various dates according to the description of work performed and the nature of the ground worked over, the climatic conditions, and the state of fair mapping. The detachments were as follows :—

i. The Sirmúr detachment, for work in the Sirmúr State forests on the 2-inch scale and a 48-inch scale survey of the town and cantonment of Náhan, the capital of the State.

ii. The Kángra detachment, for work in the Kángra district, on the 4-inch scale surveys.

iii. The Simla Hill States detachment, for work in the Simla Hill States and Hoshiárpur district, on the 2-inch scale surveys.

iv. A Triangulator, for triangulation in advance of topography, in the Hoshiárpur district.

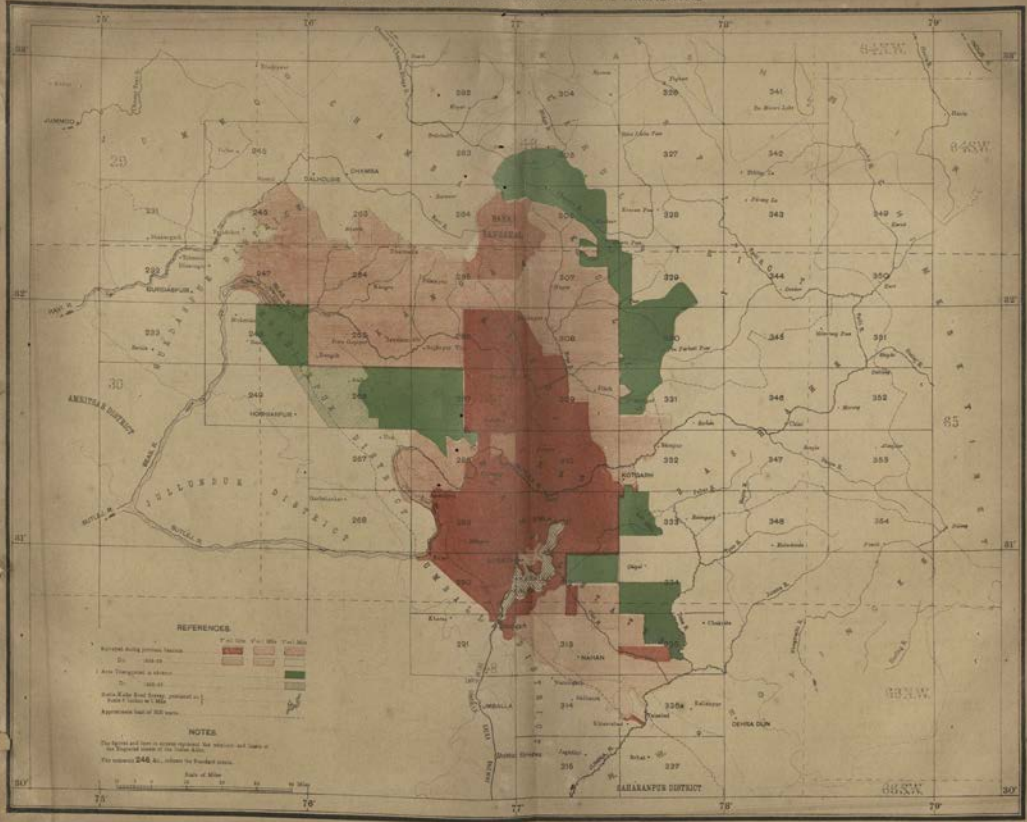
v. The Executive officer, to visit and examine progress of work in all the above detachments, left recess on the 23rd December and returned on the 20th April.

138. The Sirmúr detachment under Mr. Potter, with 7 sub-surveyors, continued the previous season's work of surveying and classifying the forests of the Sirmúr State, but on a reduced scale of 2 inches to a mile as noted in paragraph 138 of the General Report of 1897-98. The surveys were carried on in the northern part of the State on either side of the Giri river, from the main Náhan-Dagshai road to the ridges of the Chor. The highest point reached during the season's work was 11,134ft. above sea-level. The 48-inch survey of the town

* The officer in charge reports that Messrs. Wainright, Knight, and Tate deserve special mention and of the native establishment Surveyors Sher Jung, Lall Singh, and Jafar Ali have done excellent work.

PUNJAB SURVEY

INDEX TO THE SURVEY OPERATIONS IN THE HIMALAYAS



Photozincographed at the Office of the Superintendent, Survey of India, Dehra Dun.

of Náhan, at the special request and expense of the State, as noted in paragraph 139 of the General Report of 1897-98, to which was added the survey of the cantonment, on the same scale, with spirit levels over both localities, was continued, and completed during the season.

139. The Kángra detachment, under Mr. Greiff with Mr. French, and 7 sub-surveyors, continued the previous season's surveys on the 4-inch scale in the north-western portion of the Kángra district. During the winter months they worked on the low ground (about 2,000ft. above sea-level) bordering the high ranges that separate that district from the native state of Chamba, and during the spring months they moved up to the high ranges some 15,000 ft. above sea-level. The lower ground consisted, for the most part, of level stretches of land, richly cultivated and well inhabited, lying between detached hills and knolls and intersected by numerous streams with deep channels and precipitous banks. The higher ranges, of characteristic mid-Himálayan features, are uninhabited and destitute of cultivation above 7,000 ft.; and but for a few goat-tracks leading to the passes over the crests they are otherwise inaccessible. The survey of this ground was accomplished under the usual difficulties and hardships encountered by surveyors on high altitudes. All forests were also surveyed *parri passu* with the general survey of the locality, and a classification of forest growth and soils in them, was also prepared.

140. The Simla Hill States detachment, under Mr. Robert with Mr. Biggie and 8 sub-surveyors, continued the previous season's operations on the 2-inch scale in the native states of Suket and Kahlúr of the Simla Hill States, and contiguous portions of the Hoshiárpur district. The country surveyed was mostly along the valley of the Sutlej river, at an average height of 1,500 ft. above sea-level, including the remarkable loop some 55 miles long and 200 miles in area formed by the river. The survey of the Hoshiárpur district was commenced on the reduced scale of 2 inches to a mile in pursuance of the recent Government of India orders.

141. The triangulation, in advance of topography, was done by Mr. Gorman in the eastern portion of the Hoshiárpur district, along the Soán river, one of the tributaries of the Sutlej river, on either side of which run two parallel ridges, the western of Siwálik and the eastern of outer Himálayan formation rising to 2,200 ft. and about 4,000 ft., respectively, above sea-level.

142. A drawing office under Mr. Parker, with 19 draftsmen and apprentices, was left located at Simla to deal with the mapping work of the party.

143. The operations of the party were carried out in accordance with the proposed programme of the season, except the work in Kullu, which appertained to the Simla Hill States detachment, and had to be abandoned on account of the late snow falls during the spring, following a severe winter, which rendered work on high regions impracticable. Some triangulation to the north-east of Simla had also to be abandoned on account of the dense haze that enveloped the country prior to the setting in of the monsoon.

144. The outturn of the field season's work was as follows :—

	Square miles.
(*a*) Triangulation in Hoshiárpur district	315·0
(*b*) Detailed survey on the 4-inch scale in the Kángra district	156·0
(*c*) Detailed survey of the Sirmúr forests, on 2-inch scale with classification of forest growth	259·8
(*d*) Detailed survey on the 2-inch scale in Suket, Simla Hill States and Hoshiárpur districts	362·2
Detailed surveys on all scales = ...	778·0

145. The surveys of the following number of forest blocks or compartments are included in the areas shown above :—

	No. of blocks or compartments.	Area in square miles.
In Sirmúr	78	259·8
„ Kángra	22	52·6

	£
The cost per square mile for triangulation is . . .	15·2
The cost per square mile for 4-inch surveys including mapping and instruments	99·9
The cost per square mile for 2-inch surveys in the Simla Hill States including mapping and instruments . . .	68·7
The cost per square mile for 2-inch surveys, in Sirmúr State, 2-inch scale, including mapping and instruments . .	52·6

146. There was also good progress made in fair mapping as 40 sheets were sent for publication; 15 are in a very advanced state of preparation for publication; 28 and 35 proofs were examined and coloured respectively; 15 sheets of forest classification were prepared for ferrotype reproductions, and 23 coloured, and despatched to district officers; besides the compilation of tabular statements and indexes supplied to the various offices connected with the party.

147. The instruction of Native Soldier surveyors, as noted in paragraph 143 of last year's report, still continues to form one of the duties of the party. One of them, Naik Madho Ram, 44th Gurkhas, completed his course with much credit to himself, and rejoined his regiment. Sepoy Manna Singh, 5th Punjab Infantry, joined the party on 8th October 1898, and has now completed a portion of his training; and another man from the 6th Punjab Infantry has just joined for his course.

148. This party has frequently been placed under contribution for sub-surveyors on special work, two men have been absent during the season on exploration duties, another man is on deputation with the Central Africa Protectorate, and a fourth is on deputation with the Pekin Syndicate in China; a fifth, Wahid Ali Khan, was also on deputation with the Central Africa Protectorate, but returned during the recess and obtained the distinction of "*Khán Sáheb*" from the Government of India for his services; but he has since resigned his appointment for a more lucrative one in the Protectorate. All these men have been trained in this party, inured to hardships on the Himálayas, accustomed to work on various scales and in the different descriptions of ground to be met with in the Himálayas and, almost all, have been favourably reported on wherever sent.

149. In future, in accordance with the orders contained in Government of India letter No. 351-95-18, dated 11th February 1899, the scale of survey in Kángra and the hilly parts of Hoshiárpur is to be reduced from the 4-inch to the 2-inch, with the exception of the Reserved Forests which are still to be surveyed on the larger scale; in the Simla Hill States, when the 2-inch sheets, at present in progress, have been completed, the scale is to be reduced from the 2-inch to the 1-inch; and what remains for survey in Kullu is to be surveyed on the 1-inch scale. It is also proposed to survey the small area still remaining in the Sirmúr State on the 2-inch scale, as the party is under an arrangement with His Highness the Maharaja to survey his forests on that scale, His Highness paying a contribution to their cost.

150. The party was inspected by the Surveyor-General on the 11th July, and by the Superintendent, Trigonometrical Surveys, on the 12th and 13th July 1899, and both expressed their commendation of the work and efficiency of the party.*

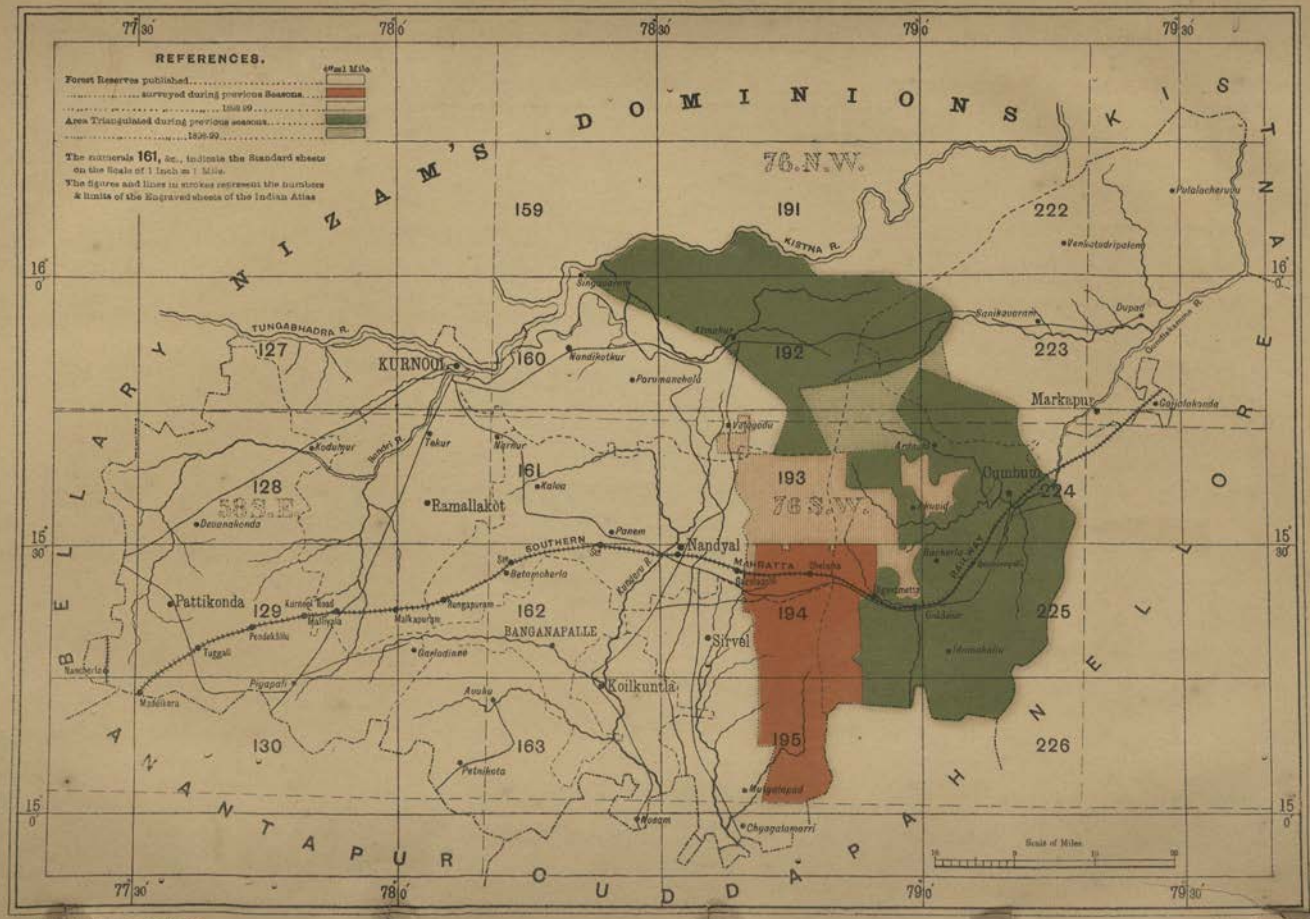
* Mr. Potter reports very favourably on the work done by Messrs. Robert, Parker, Greiff (specially), and Gorman in the management of their respective detachments; Messrs. French and Biggie promise to become good surveyors, the former especially.

Of the subordinate establishment the following are specially brought to notice:—

Amir Singh, clerk; Paras Ram, Sheopal Misar, and Amba Dutt, sub-surveyors; and Narain Dutt, draftsman.

MADRAS SURVEY.

1898-99. INDEX TO THE FOREST SURVEYS IN THE KURNOOL DISTRICT. Nos. 9 & 19 PARTIES.



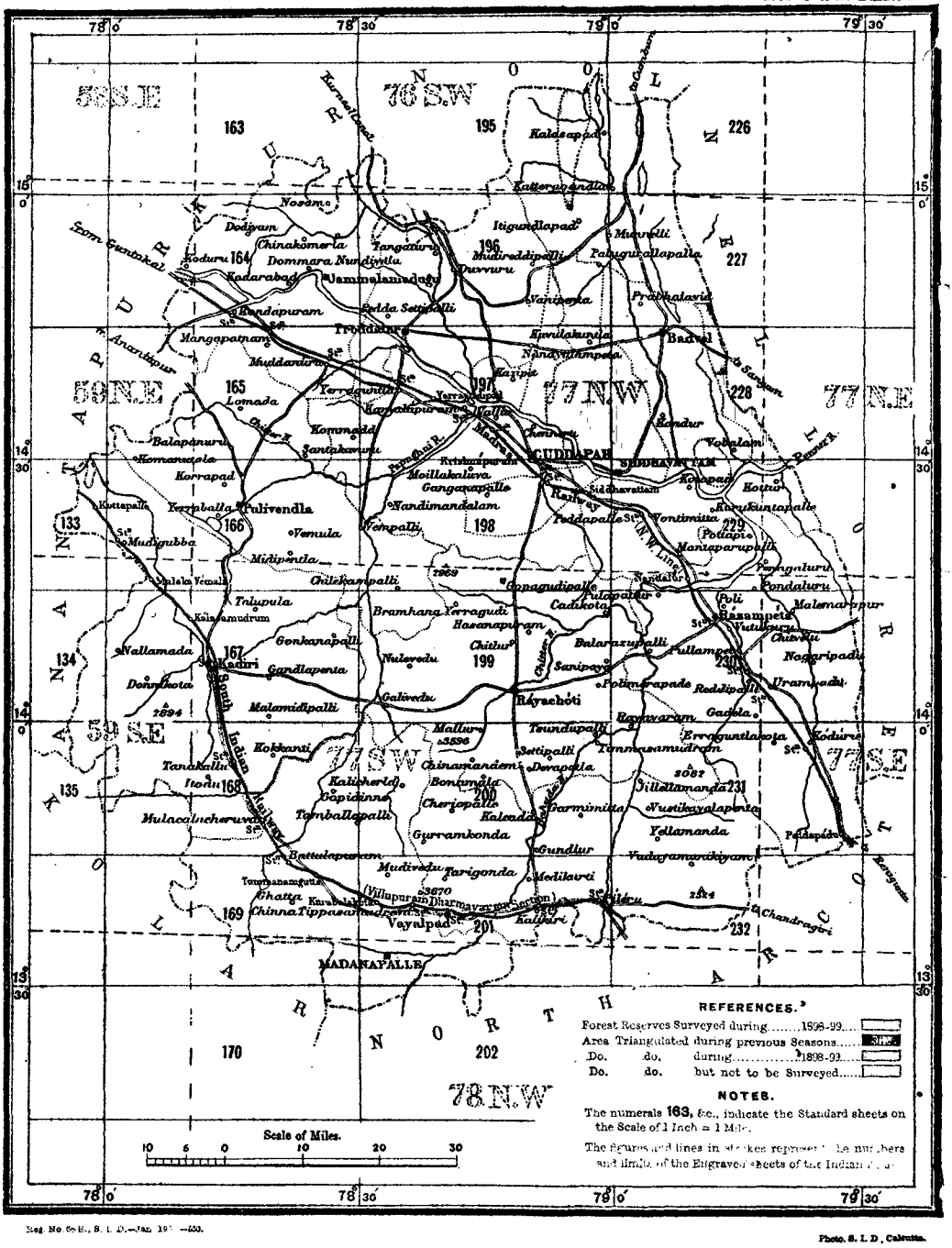
Nos. 9 & 19. 480. S. I. D.—Apr. 00.—550.

Photo. S. I. O., Calcutta.

MADRAS SURVEY.

INDEX TO THE FOREST SURVEYS IN THE CUDDAPAH DISTRICT.

1898-99. Nos. 9 & 19 PARTIES.



Reg. No. 58-R., S. I. D.—Jan. 19[illegible]—450.

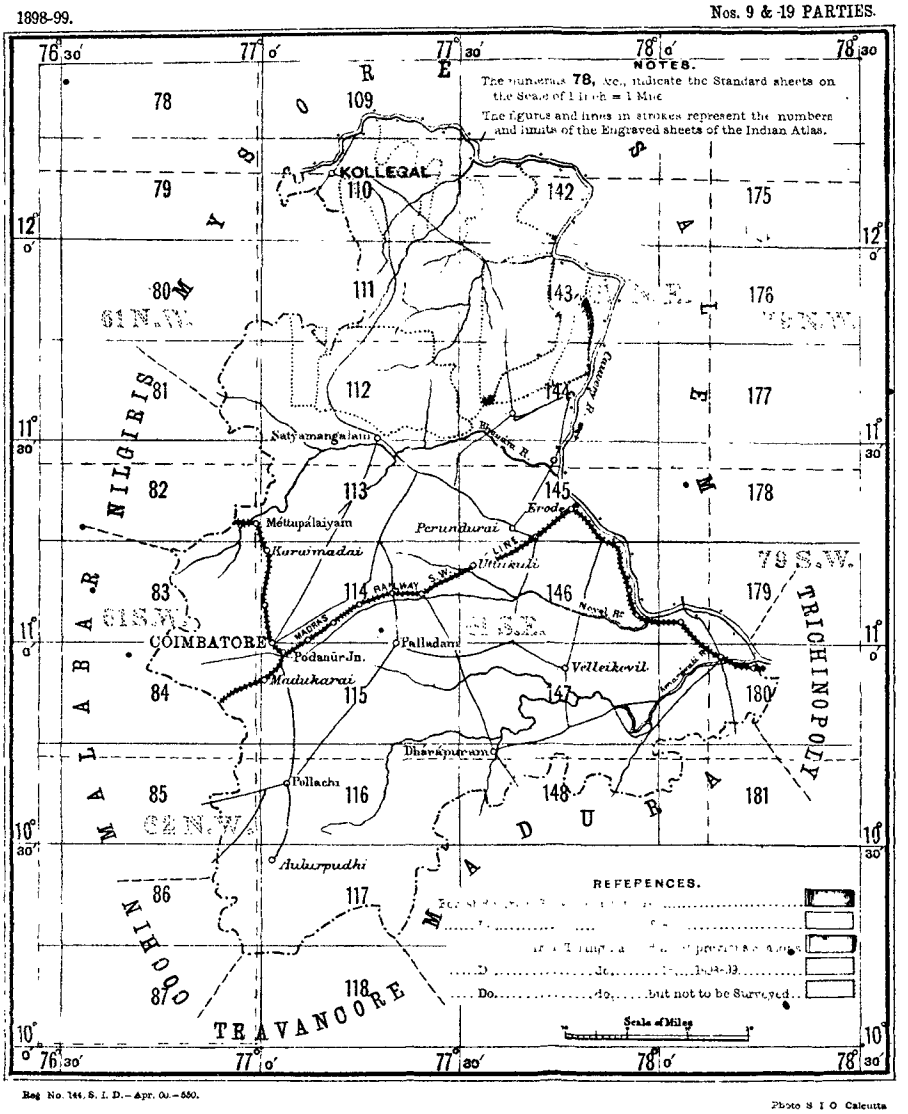
Photo. S. I. D., Calcutta.

No. 407-S. 1900.

MADRAS SURVEY.

INDEX TO THE FOREST SURVEYS IN THE COIMBATORE DISTRICT.

1898-99. Nos. 9 & 19 PARTIES.



Reg No. 144, S. I. D.—Apr. 00.—550.

Photo S I O Calcutta

No. 447-S. 00.

FOREST SURVEYS.

MADRAS PRESIDENCY.

NOS. 9 AND 19 PARTIES.

151. Under the orders of the Deputy Surveyor-General the parties were re-organized with the *personnel* reduced from that shewn in last year's report, the *personnel* is given as it was on taking the field after the reduction was completed.

Personnel.

Captain A. H. B. Hume, R.E., Officiating Deputy Superintendent, 1st grade, in charge.
Mr. C. F. Hamer, Extra Assistant Superintendent, 2nd grade.
Mr. H. Todd, Extra Assistant Superintendent, 3rd grade.
„ R. Todd, Extra Assistant Superintendent, 4th grade.
„ J. H. S. Wilson, Sub-Assistant Superintendent, 2nd grade.
Mr. M. J. Sheehan, Sub-Assistant Superintendent, 2nd grade.
60 Surveyors, sub-surveyors, and soldier surveyors and one writer.

152. The parties took the field on the 7th October 1898 and returned to recess quarters on the 11th May 1899.

153. Mr. H. Todd was placed in charge of the Northern Circle Camp, Mr. Wilson of the Central Circle Camp, and Mr. Hamer, assisted by Mr. Sheehan, of the Southern Circle Camp.

154. For triangulation Mr. R. Todd was employed first in Kurnool and then in Cuddapah. Surveyor Govind Raju and Sub-Surveyor Hilal Uddin, who was detached from the Southern Circle Survey towards the end of the season, worked in North Coimbatore. On Surveyor Govind Raju's falling sick Mr. R. Todd took up his work for the last month in North Coimbatore.

155. The programme for the Northern Circle was the continuation of the survey of the Nallamalai Hill reserves in the Kurnool district. An area of 303 square miles was completed. The triangulation was also the continuation of the same district to the north, and 150 square miles were completed and boundaries traversed for the current season and next.

For the Central Circle the programme was the mapping of the Nallamalai Hill reserves of the Cuddapah district, here 334 square miles were completed. The triangulation programme included 5 reserves south of the railway near Cuddapah, of which an area of 550 square miles was triangulated. The boundaries necessary for the current season and next were traversed.

In the Southern Circle 688 square miles were completed in the North Coimbatore district including the following reserves :—

North Bargur } (A strip remaining from last season).
South do. }
Hanur.
Kaudhalli.
Doddasampegai.
Chikialur.
Yedarhalli.

The triangulation programme included the Talamalai and Madeswaranmalai reserves, the latter were completed and 100 square miles out of the 250 of the former. The area not triangulated was reconnoitred and the East Nilgiri reserve also, but the surveyor, and afterwards an assistant, falling sick prevented its completion. The triangulation being well in advance in this district the loss is immaterial. Traverses as required for the current season and next, were completed.

156. A total of 950 square miles of triangulation was completed.

The traverse outturn was 717 linear miles, or about the normal amount.

The total detail survey outturn of 1,350 square miles is a very good one, showing an advance of nearly 30 per cent. on last season. It is decidedly the largest yet completed in a season and 170 square miles more than the programme, the outturn in each district being above the estimate.

The Kurnool outturn was considerably the largest yet done in that district though the country was particularly difficult.

The work was checked by *partal* lines and *in situ* fixings and, with few exceptions, was found well and carefully done.

157. The state of the mapping is as follows:—

Of Kurnool 11 finished maps are to be submitted and 2 held over as incomplete.

Of Cuddapah 7 finished maps are to be submitted and 5 held over.

Of North Coimbatore 18 finished maps are to be submitted and 11 held over.

Those held over are fair drawn as far as the survey is done in them.

Besides the above, 19 fair sheets of last year's survey of Salem and South Arcot have been finished, and 2 part sheets of Madura surveyed this year.

All computations have been completed and bound, and traces made for the classification of soils and forest growth.

158. The programme for next season proposes continuing the survey on the same lines in Kurnool, Cuddapah, and North Coimbatore, and commencing the triangulation of the South Canara reserves in the Southern Circle.

159. The following table shows the progressive outturn and cost-rates of the party since 1888:—

Comparison of outturn and cost-rates.

1	2	3	4	5	6	
SURVEY YEARS.	Detail survey completed in square miles.	Total cost of party for the year.	Triangulation and traverse combined cost-rate per square mile.	Detail cost-rate per square mile.	Cost-rate of party per square mile of finished work, cols. 3÷2.	REMARKS.
		₹	₹	₹	₹	
1888-89 . .	168	56,608	24	138	337	
1889-90 . .	214	71,049	29	120	332	
1890-91 . .	465	75,492	31	81	162	
1891-92 . .	659	76,347	20	77	116	
1892-93 . .	788	81,840	7	71	104	
1893-94 . .	881	78,548	11	61	89	
1894-95 . .	971	76,692	10	56	79	
1895-96 . .	964	75,900	11	54	79	
1896-97 . .	1,027	88,921	18	66	87*	Above this line No. 19 Party.
1897-98 . .	1,050	129,293	13	106	123	Below this line Nos. 9 and 19 as combined parties.
1898-99 . .	1,350	100,510	20	58	74	

* In season 1896-97 Kurnool district was commenced, which accounts for the increase in rate, and the same tends to increase the years following.

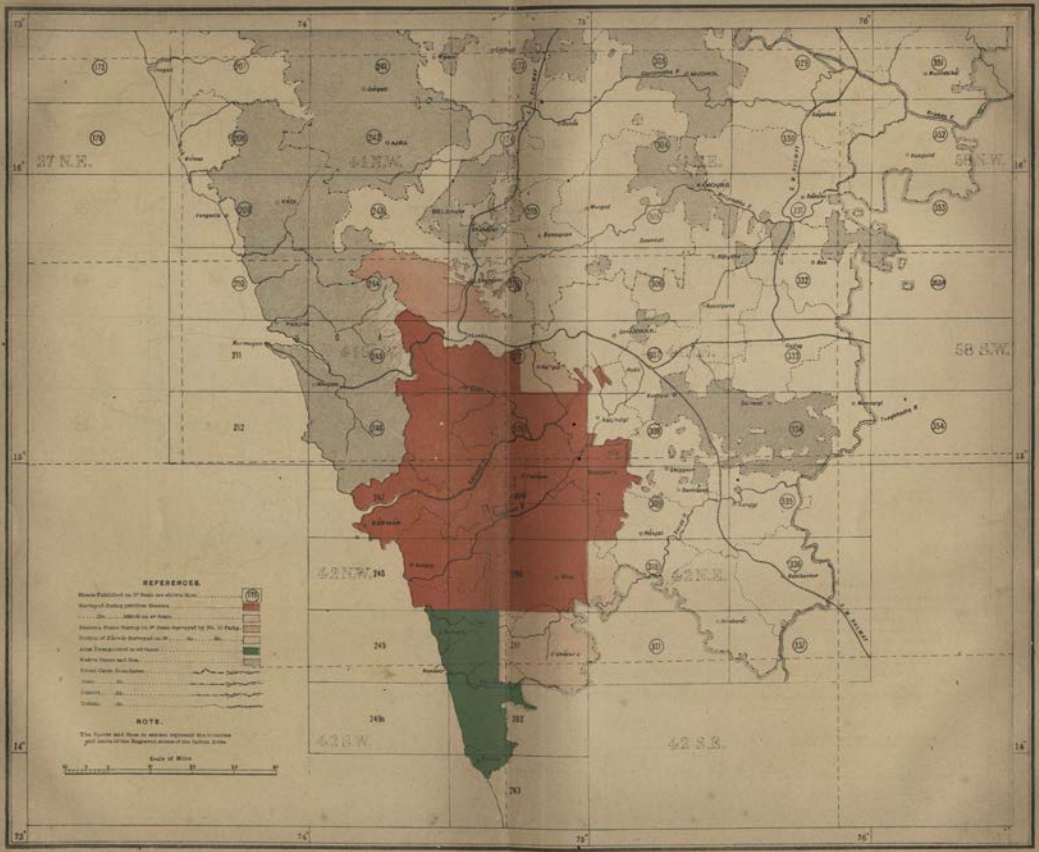
Column 6 shows that this has been decidedly the cheapest year since the work was commenced in the Presidency. The rate in column 4 appears larger than before and that in column 5 larger than in the two previous years, but these rates cannot be relied on for exact comparison as they depend on the allotment of supervision, and the larger or smaller amount of triangulation and traversing undertaken. From 1892 to 1896 easier country was under survey, and the detail cost-rate this year, if the Kurnool district figures be excluded, is ₹51 per square mile, or lower than it was in those years. Column 6 gives the fairest comparison by actual results and shows a highly satisfactory advance in the cheapness of the work. Comparison with last year's figures also shows the good effects of the re-organization that took effect from October last year.

160. Allowing for the ordinary percentage of fever, the health of the party was, on the whole, fairly good. One sub-surveyor and 2 *khalásis* died of fever. The assistant in charge of the Kurnool section suffered rather severely from fever in the field. The work of the surveyor triangulating in North Coimbatore was brought to a close mainly by ill-health, and the assistant sent there to carry on his work contracted bad fever, from which he has suffered throughout the recess. Besides the above, 5 apprentice sub-surveyors had fever at frequent intervals.

161. The country surveyed varied considerably. The Nallamalai Hill reserves of Kurnool are the most difficult on account of the thick jungle, and work has to be done mainly by traversing which is very tedious, owing to the thick thorny undergrowth. The south end of the same range of Nallamalais

BOMBAY SURVEY.

1898-99 INDEX TO THE FOREST SURVEYS IN PORTION OF THE SOUTHERN CIRCLE No. 17 PARTY.



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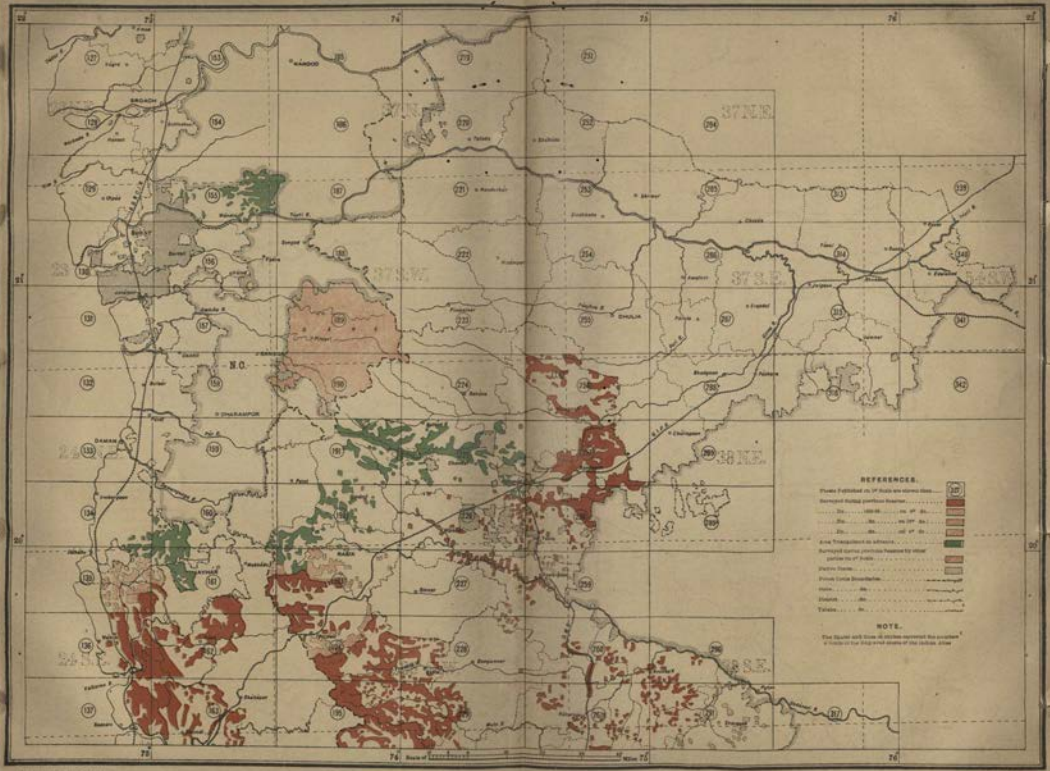
BOMBAY SURVEY.

1898-99. INDEX TO THE FOREST SURVEYS IN PORTIONS OF THE NORTHERN & CENTRAL CIRCLES. No. 17 PARTY.

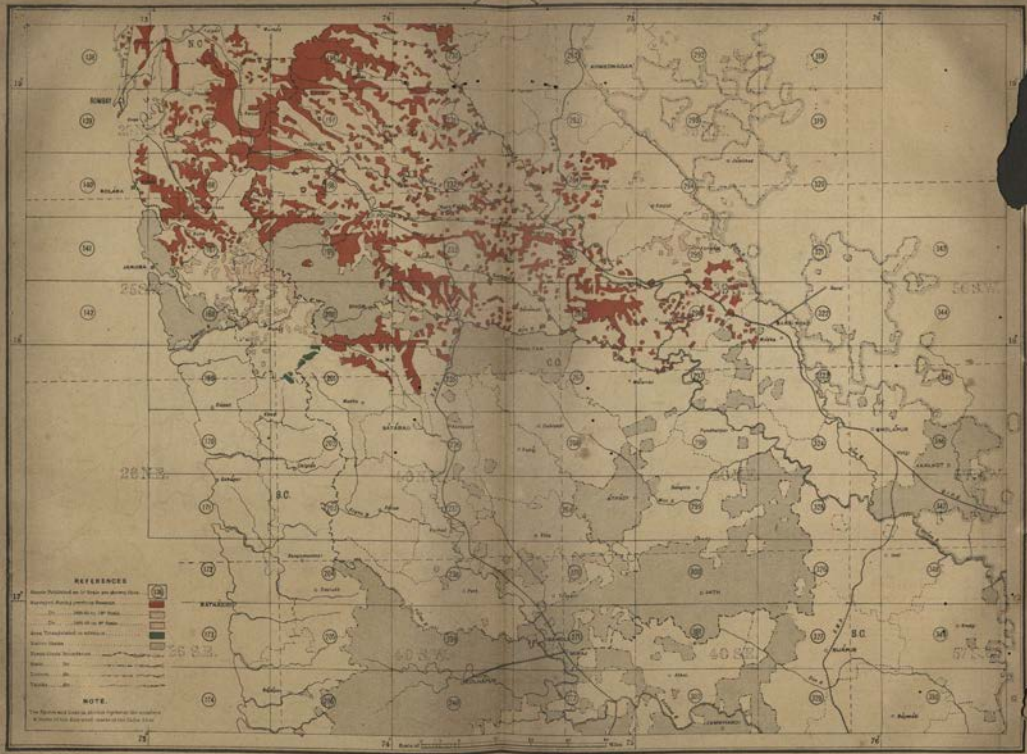


No. 538-S. 99.

BOMBAY SURVEY.

INDEX TO THE FOREST SURVEYS IN PORTIONS OF THE NORTHERN, CENTRAL, & SOUTHERN CIRCLES.

No. 17 PARTY



No. 586-3. 99.

in Cuddapah is rather more open. In parts of North Coimbatore the hills rise to nearly 6,000 feet and have areas of fine evergreen jungle.

162. Besides the work in the districts reported on above, 10 square miles were surveyed to complete the South Arcot district, and 2 square miles to complete Salem district, also the revision of some boundaries, wrongly demarcated in the previous season's survey. In Madura district, where the survey was completed some years ago, 13 square miles of new extensions were surveyed at the request of the Forest Department.

163. The Deputy Surveyor-General inspected the parties in recess on the 23rd August, and the Surveyor-General on the 26th September. Each District Forest Officer visited the recess office for several days for the verification of the maps with the notifications, and the Conservator of Forests, Northern Circle, inspected the maps on the 22nd August.*

BOMBAY PRESIDENCY.

No. 17 Party.

164. Captain Gordon held charge of the party during the field season until the 20th May 1899, when he was transferred to Calcutta to officiate as Assistant Surveyor-General in charge, Surveyor-General's Office and Mathematical Instrument Office. He was succeeded by Mr. Tapsell who continued to hold charge during the recess season.

Personnel.

*Captain P. J. Gordon, I.S.C., Deputy Superintendent, 1st grade, in charge from 1st October, 1898.

Mr. C. E. Tapsell, Extra Assistant Superintendent, 2nd grade, in charge from 20th May 1899.

Mr. S. F. Norman, Extra Assistant Superintendent, 6th grade.

Mr. C. A. Norman, Extra Assistant Superintendent, 6th grade.

Surveyors and Sub-Surveyors.

G. R. Bhopatkar, R. V. Joshi, Govind Gopal, and 36 others.

165. The first detachments left Poona in the middle of November and the last ones returned in the end of June, giving a working field season averaging six months in duration.

166. The party was divided as usual, for convenience of supervision, into three camps and a detachment as follows:—

(1) No. 1 Camp consisting of 12 surveyors under Mr. Tapsell in North Kánara.

(2) No. 2 Camp consisting of 12 surveyors under Mr. S. F. Norman in Násik up to the end of February, and afterwards until the end of the season, strengthened by 3 surveyors from No. 3 Camp, in Thána district.

(3) No. 3 Camp consisting of 10 surveyors, afterwards reduced to 6, under Mr. C. A. Norman in Kolába district.

(4) A detachment consisting of 5 surveyors under Sub-Surveyor Govind Gopal in Ahmednagar and Sholápur districts.

167. The party continued the survey on various scales, of the forest reserves in the Northern, Central, and Southern Circles of the Bombay Presidency, these operations comprising :—

(1) *In the Northern Circle.*—Preliminary triangulation in Thána. Detail survey on the 8-inch scale of the Teak reserves in Thána (Máhím and Dáhánu *tálukas*).

(2) *In the Central Circle.*—Preliminary triangulation in Násik (Násik Chándor, Kalvan, and Dindori *tálukas*). Detail survey on the 8-inch scale in Igatpuri *táluka* and on the 4, 8 and 16-inch scales in the Násik *táluka* of the Násik district, and on the 16-inch scale of the *Babul* reserves in Ahmednagar and Sholápur districts.

(3) *In the Southern Circle.*—Traversing in North Kánara. Detail survey on the 8-inch scale of the Teak reserves in Kolába district (Mahád and Mángaon *tálukas*) and on the 4-inch scale in North Kánara district.

* The officer in charge reports favourably on the work of Messrs. Hamer, H. Todd, R. Todd and Wilson.

The surveyors, sub-surveyors, and soldier surveyors, with few exceptions, are favourably mentioned. The work of the writer, Taraprosonno Roy, is also commended.

168. The following table shows in detail the cost-rates and outturn for the year under report and the two previous years :—

Description of survey.	Cost-rates. Per square mile.			Outturn.			
	1896-97.	1897-98.	1898-99.		1896-97.	1897-98.	1898-99.
	R	R	R				
Triangulation . .	21·4	19·2	18·3	(a)	229	255	230
Traversing . .	14·3	14·6	10·9	(b)	188	164	166
Topography, 4-inch .	77·6	49·4	53·2	(c)	522·0	444·25	429·15
Ditto 8 „ . .	135·7	155·7	136·6	(c)	168·0	203·81	254·02
Ditto 16 „ .	156·1	176·3	122·9	(c)	33·0	28·97	54·74

Note.—(*a*) Stations of observation. (*b*) Linear miles. (*c*) Square miles.

The improvement both in outturn and in cost-rates, notwithstanding the increase in the cost of supervision for the year under report, is very marked. The trifling increase in the cost-rates for 4-inch surveys may be disregarded, as R50 per square mile may be considered the minimum possible for 4-inch Forest Surveys in Kánara, any slight increase or decrease being due entirely to local conditions.

Owing to a clerical error in the report for 1897-98, it has been found necessary to revise the figures for that year, the rates now given are, however, more favourable than those given in last season's report.

169. As was pointed out in last year's report, a just comparison of results can best be arrived at by forming a unit of survey which will include preliminary traverse and triangulation, actual survey, fair mapping, and all supervision. It may be assumed that a square mile of completed 8 or 16-inch survey is now equal to 2½ square miles of 4-inch survey which may be taken as the normal scale of the party. The results, according to this scale of values, are for the year under report and the two previous years, as follows :—

Season.	Number of units.	Cost per unit.	Remarks.
1896-97	1024·5	80·8	
1897-98	1026·3	64·4	
1898-99	1201·1	58·1*	* Or an improvement of some 10%.
Average for three years .	1084·0	67·9	

These results, both as regards outturn and cost-rates, may be considered satisfactory.

170. A comparative statement of the total cost of the party for the past three years is given below :—

Survey year.	Total cost.		
	R	a.	p.
1896-97	82,818	4	11
1897-98	66,106	8	9
1898-99	69,287	9	6

171. It may be remarked that the increase in the cost for 1898-99, as compared with that for 1897-98, is principally due to an increase of R4,614 under the head of supervision. For this increase, however, there is a larger outturn at reduced cost rates.

172. The work was thoroughly examined and tested while in progress by the Superintendent and Camp officers.

173. During the recess, most of the fair mapping of the past season's work, has been completed. A small Drawing Office was left in Poona during the field season and brought up the arrears of mapping, and it is proposed to continue it in future for the purpose of keeping up with the increased outturn of field work.

174. All the fair maps for the Forest Department have been submitted to the Bombay Government Photo-zincographic Office and published, and the 2-inch sheets of the North Kánara district have been sent to the Head-Quarters Offices at Calcutta for reduction to one inch standard sheets.

175. The health of the party during the field season was exceptionally good, but during the recess the party did not escape the ravages of plague and two valuable surveyors and one *khalási* died from this cause. The party has thus lost the services of five thoroughly trained surveyors during the past 2 years, a severe loss in a small party of forty men, especially when it is considered that it takes several years before an apprentice can become a thoroughly qualified surveyor. The greatest credit is due to Mr. Tapsell for the excellent arrangements he made in forming a segregation camp for the members of the party and thus minimising the risk of the disease spreading in a small community, the members of which were daily brought into close contact with one another.

176. The programme for 1899-1900 is a continuation of that for the past season; Belgaum is the only new district in which operations will be commenced, and it is hoped the work in Kolába and North Kánara districts will be brought to a close.

177. The party was inspected during September by the Surveyor-General.*

LOWER BURMA.

No. 20 PARTY.

Personnel.

Mr. L. J. Pocock, Extra Deputy Superintendent, 2nd grade, in charge, from 25th November 1898 to 25th September 1899.
Mr. T. E. M. Claudius, Extra Deputy Superintendent, 2nd grade, in charge, from 26th September 1899.
Mr. C. W. Wilson, Extra Assistant Superintendent, 5th grade, officiating, in charge from 3rd October, 1898 to 24th November 1898.
Mr. A. George, Extra Assistant Superintendent, 6th grade.
„ A. Ewing, „ „ „ 6th „
„ W. C. Barckley, Sub-Assistant Superintendent, 1st grade.
„ H. A. Charrier, „ „ 1st „
54 Surveyors, Sub-Surveyors, etc.

178. Mr. L. J. Pocock was in charge of this party from the 25th of November 1898 till he retired on the 25th of September 1899, when Mr. T. E. M. Claudius assumed charge.

179. The work of the party, as in former years, comprised—

(i) Detail survey of portions of the South Zamayi and Kadat reserves in the Pegu forest division, the Nyabwa Zaha Kowliya and Tongan reserves in the Shwegyin division; the Thayetmyo East Yoma, Tindow, and Setsuwa reserves in the Thayetmyo division and Hmawbi and Kyetpugon reserves in the Rangoon division, all on the scale of 4 inches=1 mile, except Kyetpugon which was done on the 8 inches=1 mile scale.

(ii) Detail survey of portions of standard sheets 271, 274, and 323 of unreserved forests, to fill up gaps, on the scale of 2 inches=1 mile.

(iii) Triangulation in advance of topography in the West Salween forest division.

(iv) The classification of forest growth and soils *pari passu* with the topography of the reserved forests.

(v) Theodolite traverses based on the triangulation, as a basis for the detail work in the Thayetmyo, Toungoo, Shwegyin, West Sal-

* Much credit is due to Messrs. Tapsell and S. F. Norman for the efficient way in which they performed their duties. Most of the surveyors worked to my entire satisfaction; G. B. Bhopatkar, Mahsud Khan, Yemla Piraji, Hari Ramchandra, as plane tablers, N. R. Patwardhan as a triangulator, and Ganesh Balal as a draftsman are specially deserving of mention.

ween and Ataran forest divisions; in the last named the traverse work was based on Great Trigonometrical Survey points of the Eastern Frontier Series.

180. The party left recess quarters at Bangalore about the 10th of November and commenced field work in the first to third week of December, according to the distance of the field of operations from Pegu. The recess quarters of the party have been changed to Dehra Dún, and the party has been amalgamated with the Forest Surveys of the Bengal Presidency and has been placed under the administrative charge of the Superintendent of Forest Surveys, in keeping with the orders of the Government of India, in their Resolution Circular No. $\frac{6}{143\text{-}3}$F. of the 6th March 1899, Revenue and Agricultural Department. The recess office was opened in the beginning of the first week of June.

181. The party was divided into six sections, the head-quarters and traverse camp being in charge of the Executive Officer. Three detail survey camps were under charge of Messrs. George, Ewing, and Charrier, respectively, while the triangulation was carried on by Mr. Barckley assisted by Surveyor Amjad Ali. All the detachments left Pegu on various dates between the last week of November and the first week of December.

182. The outturn of the field season's work was as follows:—

	Square miles.
(*a*) Triangulation in the West Salween forest division	1,200
(*b*) Theodolite traversing for the 4-inch scale	186
(*c*) Detail survey on the 4-inch scale	472
(*d*) " " " " 2-inch "	87
(*e*) " " " " 8-inch "	1·4

183. The usual test lines were applied to the detail work by the camp officers, who constantly visited the surveyors at work, which as a rule, proved of good quality; one case having been found otherwise, for which the surveyor's pay was reduced by the Deputy Surveyor-General.

184. The traverse work was conducted by Mr. Pocock, no assistant being available for this work. Considering the difficult and scattered nature of the reserves which entailed considerable loss of time in marching from one to the other, and sickness among the traversers, a good outturn was completed.

185. The outturn of 4-inch detail work is larger than ever before done by this party, but the 2-inch work has decreased.

186. The cost-rate of survey, as seen from the following table, shows—

Year.	Cost-rate per square mile.				
	Triangulation.	Traversing.	Detail Survey.		
			4-inch scale.	2-inch scale.	8-inch scale.
	R	*R*	*R*	*R*	*R*
1891-92	35·2	150·6	175·3	66·2	...
1892-93	33·2	138·1	160·1	60·9	...
1893-94	36·9	133·9	159·3	83·5	...
1894-95	30·1	94·0	153·5	176·0	...
1895-96	21·2	58·5	158·1	83·5	...
1896-97	...	83·5	173·2	50·5	...
1897-98	...	57·4	196·4	79·4	...
1898-99	14·6	132·8	155·4	86·4	131·4

The cost-rate for traverse work is high, but the cost per square mile is not a fair comparison, as all the work done this year is for 4-inch survey only, embracing a much smaller area than if similar work had been needed for 2-inch survey.

The cost-rate for detail survey is lower than last year. The early beginning of the monsoon reduced the last month's outturn somewhat or the area finished would have been greater. The new hands which joined the party from the Dehra Training School required further tuition before they could take up independent work in the very difficult country operated in by this party.

187. The country was very difficult for survey work, consisting of intricate hills covered with dense jungle. The health of the party was on the whole good. Three *khalásis* were carried off by tigers, which caused some delay in the work, and one sub-surveyor and one *khalási* died from fever. Most of the surveyors were provided with guns and ammunition, which gave them some confidence.

188. No supplies, except small quantities of rice, being obtainable near the work, food depôts had to be established, and the supply and distribution of provisions was successfully done by the party. The elephants attached to the party were of the greatest use for transporting the provisions.

189. During the recess all the computations and 4-inch mapping have been brought up to date.

Thirty-five 4-inch sheets were submitted for publication, and three more sheets will be submitted during the field season.

190. The programme for next season comprises :—

(1) *Eastern Circle.*—The survey of the Sinthe reserve in the Pyinmana forest division.

The unsurveyed portion of the Ruby mines forest reserve will be triangulated and traversed for future topography.

(2) *Tenasserim Circle.*—Survey operations in the Ataran division will be carried on in the Kyunchaung and Ye forests and teak-bearing tracts contiguous to the former. In the West Salween division, all the reserved forests will be topographically surveyed, (except Pachaung which will be prepared for topography during 1899-1900), and the balance of the unsurveyed forest reserves in the Toungoo and Shwegyin divisions.

(3) *Pegu Circle.*—An area of about 157 miles will be topographically surveyed, comprising the Ohnezan, Thègôn, and Sinmadaung reserves in the Thayetmyo division, Wanetchaung in the Rangoon division, and Shwelaung Kodugwe and Salu in the Pegu division.

191. The party was inspected by the Deputy Surveyor-General, Revenue Branch, in the field, in December 1898.*

OPERATIONS OF THE FOREST SURVEY BRANCH.

192. Mr. W. H. Reynolds, Superintendent of Forest Surveys, held administrative charge throughout the year under the orders of the Inspector General of Forests and the professional control of the Surveyor-General.

During the year (*vide* orders marginally noted) No. 20 Party of the Survey of India Department has been amalgamated with the Forest Surveys of the Bengal Presidency, and has been brought under the administrative charge of the Superintendent of Forest Surveys.

Government of India, Department of Revenue and Agriculture (Forests), Resolution Circular No. $\frac{6}{143-3}$ F., dated 6th March 1899.

193. The field operations of the year were carried on in seven districts of the Central Provinces, in the Chamba State and Montgomery district of the Punjab, in several districts in Oudh and in three districts in Upper and Lower Burma. No. 20 Survey Party was employed entirely in Lower Burma.

194. In addition to No. 20 Party, the field establishments comprised twelve separate detachments, each of which worked under European supervision or under reliable and trustworthy native assistants.

* Mr. Pocock reports very favourably of the work done by Messrs. George, Ewing, and Charrier, who, as heads of sections, supervised their camps efficiently. Of the subordinate establishment, Surveyors Awjad Ali and Sharifudin, and writer Muhammad Abdul Karim are favorably reported.

The total outturn of field work for the year is as follows:—

Name of Party.	Triangulation.	Traversing (linear miles).	Levelling (linear miles).	Detail Survey in square miles.				
				1 inch.	2 inches.	4 inches.	8 inches.	16 inches
Forest Surveys	1,092	561	839	953	...	1,931	...	326
No. 20 Survey Party . . .	1,200	201	...	...	87	472	1·44	...
Total .	2,292	762	839	953	87	2,403	1·44	326
				3,770·44				

The detail survey on the 1-inch and 2-inch scales was done for topographical purposes.

The topographical work was tested by running 720 linear miles of *partál* or check surveys through it, and the instrumental contours which were run at fixed vertical intervals in the Central Provinces and Chamba Surveys, also afforded a further check on the detail survey, 220 miles of *partál* surveys were also run through the detail surveys done by No. 20 Party.

195. For purposes of comparison with the previous year's outturn, the following statement for 1897-98 is added:—

Name of Party.	Triangulation (square miles).	Traversing (linear miles).	Levelling (linear miles).	Detail Survey in square miles.				
				1 inch.	2 inches.	4 inches	8 inches.	16 inches
Forest Surveys	2,617	395	672	200	...	1,501	...	236
No. 20 Survey Party . . .	...	724	...	...	118	406	...	...
Total .	2,617	1,119	672	200	118	1,907	...	236
				2,461 square miles.				

From the foregoing statements it will be seen that, except the 2-inch work, all the outturn of detail surveys, on the several scales, is in excess of what it was in the previous years and so also is the traversing and levelling against Forest Surveys, as well as triangulation against No. 20 Party. The triangulation against Forest Surveys is less than in the previous year, which is due to this branch of the work, both in the Himálayas and some of the districts in the Central Provinces, being sufficiently in advance of the detail survey.

196. The cost-rates per square mile, by Provinces, of the detail surveys, are as follows:—

Province.	Detail Survey.			
	1 inch.	2 inches.	4 inches.	8 inches.
	₹	₹	₹	₹,
Central Provinces . . .	...	...	38·8	...
Punjab	7·8	...	41·3	...
Burma (Forest Survey) . .	...	...	93·8	...

The above cost-rates compare favourably with those of the previous year.

197. For all forest areas surveyed on the 4-inch scale the usual records of forest distribution and classification of soils were prepared.

198. During the field season Mr. W. H. Reynolds, Superintendent of Forest Surveys, visited in turn, each of the several field detachments in Burma, the

Central Provinces, and the Punjab, and satisfied himself that the field work was being efficiently conducted. Also, by special request, he inspected the field office of No. 20 Survey Party.

CENTRAL PROVINCES.

199. Six separate forest survey detachments were employed during the year on field operations in the Central Provinces. The forests operated on were those in the districts of (i) Biláspur, (ii) Chhindwára, (iii) Nágpur and Wardha with Chánda, (iv) Seoni, (v) Sambalpur, and (vi) Saugor. All the survey operations, except those in the Sambalpur and Chánda districts, were in continuation of the previous year's work.

Personnel.

Mr. T. S. Marten, Extra Assistant Superintendent, 5th grade.
„ J. Marten, Extra Assistant Superintendent, 6th grade.
„ B. R. Hughes, Sub-Assistant Superintendent, 1st grade.
„ J. H. Nichol, Sub-Assistant Superintendent, 1st grade.
„ C. Litchfield, Sub-Assistant Superintendent, 1st grade.
Babu Oodey Singh, Forest Surveyor.
99 Native Surveyors.

200. The several survey detachments took the field about the middle of November and returned to recess quarters on various dates between the 10th June and 8th July.

201. The following statement exhibits the areas surveyed and the expenditure and cost-rate per square mile on each branch of the work:—

Forest Division.	Cost of				Total expenditure.
	Detail survey 4 and 16-inch, including mapping.	Triangulation.	Traversing.	Levelling.	
	₹	₹	₹	₹	₹
Saugor	17,328	2,770	...	...	20,098
Biláspur	10,276	...	790	...	11,066
Seoni	11,838	...	497	1,246	13,581
Chhindwára	10,730	1,929	...	...	12,659
Nágpur-Wardha with Chánda	9,360	...	...	2,832	12,192
Sambalpur	9,504	...	...	...	9,504
Total expenditure	69,036	4,699	1,287	4,078	79,100
Total areas, square miles	1,780	825	53·5*	827*	
Cost per square mile in Rs.	38·8	5·7	24·1†	4·9†	

* Linear miles.
† Cost per linear mile in Rupees.

202. The total area topographically surveyed in detail was 1,780 square miles; of this area 1,454 square miles were done on the 4-inch scale and comprise the interior survey of the reserved forests and 326 square miles were surveyed on the 16-inch scale. The larger scale survey comprises work along the forest boundaries and was done, as explained in previous reports, for the purpose of securing a large scale indisputable boundary record of the Government forest reserves. The outturn for the previous season was 902 square miles on the 4-inch scale and 236 on the larger scale, showing an increase, for the present year, of 552 square miles on the 4-inch scale, as well as an increase of 90 square miles on the 16-inch scale.

203. Triangulation was extended in the Chhindwára and Saugor districts; the work in the former district was done by Mr. J. H. Nichol, and in the latter district the triangulation was done by Mr. T. S. Marten. Some traversing was done in the districts of Biláspur and Seoni for the purpose of connecting the old revenue survey traversing with the triangulation of the province, with the object of reducing the traverse measurements to those of the triangulation. In the Seoni and Chánda districts where the trigonometrical stations were few and far part, and in the denser parts of the forests, it was found necessary to run lines

of spirit levels to afford a sufficient and ample basis for adding instrumental contours to the topographical work.

204. The detail survey was tested by running 501 miles of *partál* or check surveys through it and no serious errors were brought to notice, and the instrumental contours, which were run at 250 feet vertical intervals, afforded a further check on the topographical work.

205. A large amount of work has been completed in the way of mapping: 129 forest sheets, on the 4-inch scale, have been published during the year, 45 are in the press and 163 sheets are in different stages of progress.

206. The average cost-rate per square mile of the detail topographical surveys was R39, as compared with R41 in the previous year and R43 in 1896-97.

207. Mr. W. H. Reynolds, Superintendent of Forest Surveys, was in the Central Provinces from the 16th February to the middle of March, and inspected the field work of the several survey detachments whilst the work was in progress.

PUNJAB.

208. In the Punjab, survey operations were conducted in the Chamba State, as well as in the Montgomery Forest Division. The Chamba survey was in continuation of the previous year's operations, and the survey of the Montgomery reserves was commenced during the year under report.

Personnel.

Mr. J. Marten, Extra Assistant Superintendent, 6th grade.
Mr. B. R. Hughes, Sub-Assistant Superintendent, 1st grade.
16 Native Surveyors.

209. Triangulation was extended in the Chamba State over an area of 267 square miles situated in the north-east corner of the State touching on Zaskar and Láhul and at elevations of from 7,000 to 21,000 feet above sea-level. This branch of the work, which was an arduous undertaking, was done by Mr. B. R. Hughes, and this season's outturn completes the triangulation of the Chamba State.

210. Topographical operations were carried on entirely in the Pangi Valley and in the more elevated and sparsely populated tracts of Chamba. The leased forests which were brought under survey during the year, are situated for the most part on the Chandra Bhága river and its main tributaries, and were surveyed on the 4-inch scale; the tracts, beyond forest limits, were surveyed on the 1-inch scale for the purpose of completing the topographical map of the Chamba State. The 4-inch survey, as well as the western portion of the 1-inch work, was entrusted to Mr. J. Marten, and Mr. Hughes also assisted in the 1-inch topographical survey.

211. In the Montgomery district the survey was confined to the traversing of forest boundaries and the detail survey of a narrow tract on either side of the boundary lines.

212. The following statement gives the areas surveyed in the Punjab and the expenditure and cost-rate per square mile on each branch of the work:—

Forest Division.	Cost of				Total expenditure.
	1-inch detail survey, including mapping.	4-inch detail survey, including mapping.	Triangulation.	Traversing.	
	R	*R*	*R*	*R*	*R*
Chamba	7,436	4,128	3,249	...	14,813
Montgomery . . .	...	...	...	1,681	1,681
Total expenditure . .	7,436	4,128	3,249	1,681	16,494
Total areas, square miles .	953	100	267	380·2*	
Cost per square mile in Rs. .	7·8	41·3	12·2	4·4†	...

* Linear miles.
† Cost per linear mile in Rupees.

213. The total expenditure on account of survey operations in the Punjab was R16,726, of which R14,813 were spent on surveys in the Chamba State, and an expenditure of R1,681 was incurred for surveys in the Montgomery division, whilst R232 were expended on map drawing and the publications of maps of areas previously surveyed in the Bashahr State.

NORTH-WESTERN PROVINCES AND OUDH.

214. Nothing beyond forest boundary surveys was undertaken in the North-Western Provinces and Oudh. The final demarcation of many of the Oudh forest boundaries, by permanent marks, is still incomplete, and hence delays have occurred in issuing the new maps.

215. A small survey detachment was employed in the districts of Pilibhít, Kheri, Bahraich, and Gorakhpur in surveying the newly erected monoliths on forest boundaries, and a few surveyors will again have to proceed to Oudh during the coming field season to continue the survey of the boundaries, the demarcation of which was incomplete at the close of last field season.

216. A total length of 611 miles of boundary was measured and the details added to the existing 4-inch maps at an average cost of R3·4 per mile.

217. It was remarked in last year's report that the re-aligned Nepál-Kheri boundary would not be shewn on forest maps until the new boundary had been finally approved by Government. This boundary has now been approved, and it will, accordingly, appear on the new maps.

BURMA.

218. The forest surveys in Burma were in continuation of the previous year's operations. Three detachments were employed, and the forests surveyed were situated in the divisions of—

Personnel.

Babu Bhup Singh, Native Surveyor.
„ Dalip Singh, ditto.
„ Oodey Ram, ditto.
and 30 other Native Surveyors.

(i) Ruby Mines } in Upper Burma.
(ii) Pyinmana }
(iii) Salween-Ataran in Lower Burma.

219. No. 20 Party was also employed on forest surveys in the Pegu and Tenasserim Circles.

220. The three forest survey detachments left Dehra on the 21st November and were again in recess quarters early in July. No. 20 Party left Bangalore about the 10th November; all the field squads were at work by the third week of December and the party returned to its recess quarters at Dehra Dún early in June.

221. On the 1st April 1899 Party No. 20 was brought under the administrative charge of the Superintendent of Forest Surveys, and is now amalgamated with the forest surveys of the Bengal Presidency, in keeping with the orders of the Government of India marginally noted.

Government of India (Revenue and Agricultural Department) Circular No. $\frac{6}{143-3}$ F., dated 6th March 1899.

The following statement gives the areas surveyed by the three forest survey detachments, as well as the expenditure and cost-rate per square mile on each class of survey:—

Forest Division.	Cost of		Total expenditure.
	Traversing.	4-inch detail survey, including mapping.	
	R	R	R
Tenasserim	3,372	13,800	17,172
Pyinmana	...	7,044	7,044
Ruby Mines	3,592	14,503	18,095
Total expenditure	6,964	35,347	42,311
Total areas, square miles	127·6*	377	
Cost per square mile in Rs.	54·6†	93·8	...

* Linear miles.
† Cost per linear mile in Rupees.

From the above statements it will be seen that the cost-rates compare favourably with those of previous years.

222. The detail survey was tested, as usual, by running *partál* or check surveys through the topographical work after it had been completed. By the forest survey detachments 219 linear miles of test surveys were run and No. 20 Party measured 220 miles of *partál* lines.

223. The fair mapping has made good progress during the year; 17 sheets have been published, 36 are in the press and 34 are in different stages of progress.

224. Mr. W. H. Reynolds, Superintendent of Forest Surveys, was in Burma from 16th January to 6th February and visited, in turn, each of the survey detachments and, by special request, he also inspected the field office of No. 20 Party prior to its amalgamation with the Forest Survey Branch.

225. During the field season of 1899-1900 all the forest survey detachments in Burma will work under the Executive Officer in charge of No. 20 Party, and the combined establishments will be employed on surveying the forests in the Ruby Mines and Pyinmana divisions in Upper Burma, as well as the reserves in the Pegu and Tenasserim forest circles in Lower Burma.

226. The operations, in detail, of No. 20 Party are reported on separately.*

CADASTRAL SURVEYS.

BENGAL.

No. 4 PARTY.

227. The survey programme in the Province of Bengal consisted of the following:—

Personnel.

Captain R. T. Crichton, I.S.C., Deputy Superintendent, 1st. grade (up to 26th April 1899).
Captain C. W. H. Symonds, I.S.C., Officiating Deputy Superintendent, 1st grade (from 26th April 1899).
Lieutenant A Mears, I.S.C., Assistant Superintendent, 1st grade.
Mr. H. Dowman, Extra Assistant Superintendent, 1st grade.
Mr. A. W. Smart, Extra Assistant Superintendent, 5th grade.
Mr, C. S. Kraal, Extra Assistant Superintendent, 6th grade.
Mr. E. F. Berkeley, Extra Assistant Superintendent, 6th grade.
Mr. T. W. Babonau, Sub-Assistant Superintendent, 1st grade.
Mr. C. S. Gasper, Sub-Assistant Superintendent, 1st grade.
Babu Nilmoni Chatterji, Sub-Assistant Superintendent, 2nd grade.
Mr. H. H. B. Hanby, Sub-Assistant Superintendent, 2nd grade.
Mr. P. L. Causley, Sub-Assistant Superintendent, 2nd grade
Mr. E. G. Hardinge, Sub-Assistant Superintendent, 3rd grade.
73 Supervisors and Inspectors,
65 Surveyors and Sub-Surveyors.
30 Computers.
31 Estimators, Draftsmen and Writers.
246 Amins (local).
402 „ (imported).

	Square miles.
(*a*) In Sáran—	
Traverse survey	143
Cadastral survey	535
Topographical survey	87
(*b*) In Darbhanga—	
Traverse survey	521
Cadastral survey	680
(*c*) In Backergunge—	
Traverse survey	150
(*d*) In Champáran—	
Traverse survey	125
Topographical survey	90
(*e*) In Burdwan—	
Traverse survey	88
Topographical survey	88
(*f*) In Darbhanga City—	
Traverse survey	7
Topographical survey	7
(*g*) In Chapra City—	
Traverse survey	7
Topographical survey	7
(*h*) In the Sháhabad Division—	
Traverse survey	15
Topographical survey	15
(*i*) In Sonthal Parganas—	
Traverse Survey	631

In addition to the above the relaying of certain boundary marks on the Nepál and the Kachnar *mahal* boundaries was sanctioned.

228. The general principles which have been in vogue during preceding years have been fully maintained during the season under report.

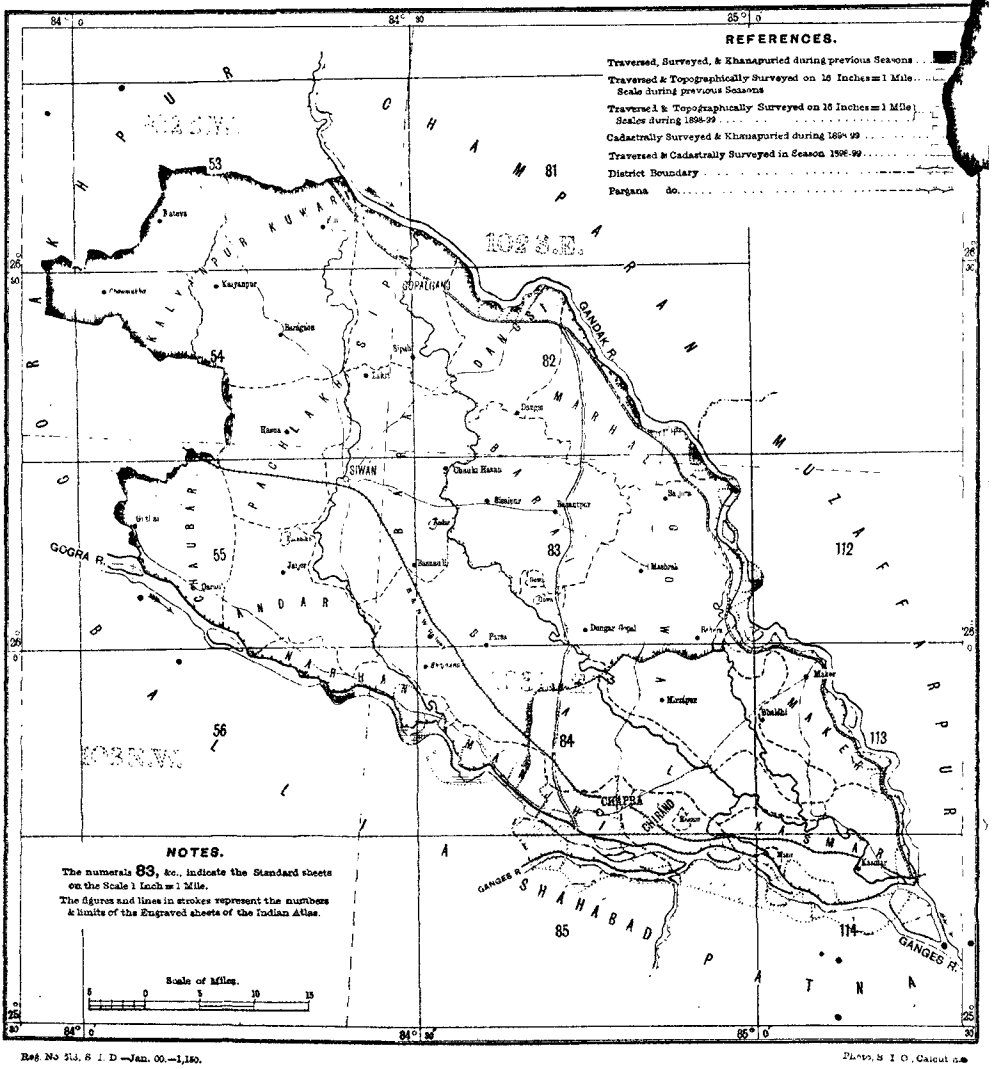
All villages lying in the *diára* were treated as follows:—

(*a*) *Villages permanently settled.*—The external boundaries were mapped on the 16-inch scale, topographical features (*i.e.*, roads, etc.) being shown.

* Mr. Reynolds speaks in the highest terms of the officers of the Provincial Service; they have, one and all, co-operated willingly and cheerfully in the season's work, and the results of their labours are most creditable to themselves and have met with the Superintendent's entire satisfaction.

BENGAL SURVEY.

1898-99. **INDEX TO THE CADASTRAL SURVEY IN DISTRICT SARAN** No. 4 PARTY.


REFERENCES.
Traversed, Surveyed, & Khanapuried during previous Seasons
Traversed & Topographically Surveyed on 16 Inches=1 Mile Scale during previous Seasons
Traversed & Topographically Surveyed on 16 Inches=1 Mile Scales during 1898-99
Cadastrally Surveyed & Khanapuried during 1898-99
Traversed & Cadastrally Surveyed in Season 1898-99
District Boundary
Pargana do.
NOTES.
The numerals 83, &c., indicate the Standard sheets on the Scale 1 Inch = 1 Mile.
The figures and lines in strokes represent the numbers & limits of the Engraved sheets of the Indian Atlas.
Scale of Miles.
GOGRA R.
GANDAK R.
GANGES R.
SIWAN
CHAPRA
SHAHABAD
MUZAFFARPUR
102 S.E.
103 S.W.

Reg. No 513. S. I. D.—Jan. 00.—1,150.

Photo. S. I. O., Calcutta.

No. 406-S. 1900.

(*b*) *Villages temporarily settled but not belonging to Government* were dealt with in the same way as permanently settled villages, but references were made to the Collector, and in special cases, such as the impending close of an existing settlement, a detailed survey was made, if required.

(*c*) *Villages belonging to Government* were surveyed cadastrally, *khasras* written and *khánápuri* done. The *khánápuri* Settlement Officer, in addition to deciding boundary disputes, passed, orders on all disputes entered in the list. The records were then made over to the Collector for any further action he deemed advisable.

(*d*) *Villages partly belonging to Government and partly permanently or temporarily settled* (*but not the property of Government*) *or both* were treated in the same manner as villages entirely belonging to Government. Government villages, not on the river side of the *diára* line, were surveyed and settled under the Bengal Tenancy Act in accordance with Government orders. Lists were sent to the Collector, of villages proposed for treatment (1) as permanent, (2) as *diára*.

229. During the season, there were no serious complaints regarding the temporary demarcation of village boundaries, with the exception of villages lying in the Sáran *diára*. Here it was very defective. This is due to the fact that the *raiyats* were unable to point out their boundaries in waste land tracts. With a view to secure the better attendance of *raiyats*, a new form was introduced, which was supplied to each *amin*, who entered in the proper columns the numbers of the fields, and the names of those whose attendance was required for either survey or *khánápuri*. Each of the interested parties signed against those fields in which they had vested interests. The introduction of this procedure reduced the reports for non-attendance to $\frac{1}{9}$th in the Sáran district. It was equally effective in Darbhanga.

All village sites were surveyed on a scale of 64 inches=1 mile which necessitated the use of 1,241 additional sheets.

No free labour was provided. The three coolies attached to each *amin* were paid at a uniform rate of $1\frac{1}{2}$ annas per diem, with the exception of those employed in the survey of the Darbhanga City where it was found necessary to pay them at a rate of annas 2 per diem.

230. The following civilians went through a course of survey and settlement work, in accordance with the rules drawn up by Captain Crichton and Mr. Stevenson-Moore. Messrs. Johnston, Woodman, Hignell, Strong, and Cornes in the Sáran district, and Messrs. Crump, Thomas, Salkeld, Cammiade, Mellor, and Gourlay in the Darbhanga district.

SÁRAN DISTRICT.

231. *Traverse Survey.*—The traverse section, which was under the supervision of Mr. H. Dowman, took the field on the 1st of November 1898 and returned to recess quarters at Mussooree on the 20th of April 1899.

The whole area traversed lies within the following *thánas*: Mánjhi, Mashrak, Chapra, Sonpur, and Parsa, and is contained in 6 river circuits, which were again sub-divided into 21 sub-circuits. The urban area of the Chapra Municipality was contained in one sub-circuit, sub-divided into 40 blocks.

The preliminary demarcation, which was carried out by the villagers themselves, was found to be satisfactory. No opposition was experienced, and willing assistance was invariably afforded.

232. *Cadastral survey and writing of Records.*—This section was under the supervision of Mr. A. W. Smart, assisted by Messrs. E. F. Berkeley (up to 12th November 1898), C. S. Gasper (from 1st July 1899), H. H. B. Hanby, P. L. Causley, and H. H. Taylor (up to 21st March 1899). The native establishment consisted of the following: 3 head-inspectors, 30 inspectors, 205 foreign, and 103 local, *amins*; 308 *moharrirs* and 490 *mirdhas* together with the usual office establishment. During recess the above strength was reduced to 278 *amins* and 255 *moharrirs*. Field operations commenced on the 5th of November and closed on the 20th of April, on which date the establishment returned to recess

quarters at Dígha. Owing to their being under water, three villages were not completed until the 16th of June 1899.

The programme in this district consisted of the completion of *thánas* Chapra, Parsa, and Sonpur. As usual the tenures were of a very intricate nature and the size of the fields extremely small.

The area is mapped on 1,825 sheets, which include 551 sheets of village sites which were mapped on a scale of 64 inches=1 mile. The average size of the field was the same as that of the previous season, namely ·3 of an acre.

In order to check the accuracy of the detail survey, 1,871 linear miles of *partáls* were run by European officers, and independently. The amount of *partáls*, run by inspectors was 1,645 linear miles, giving a total of 3,516 linear miles, which gives an incidence of 6·41 linear miles per square mile of survey. In the survey of village sites on the 64 inches=1 mile scale, portions of 330 were re-surveyed as an independent check and as a further check 1,522 chains of *partál* were run through the main streets and alleys. The results of these checks proved the work to be excellent.

Of the total number of fields, namely, 1,157,451; 9,689 entries were checked by European officers and 301,352 by inspectors, which brings the average number checked to 26·9 per cent. This check is exclusive of that done by Assistant Settlement Officers and *kanungos*.

The cost-rate for detail survey amounted to R72 per square mile, and for record writing, etc., to R59 per square mile.

The health of the establishment was excellent during the field season, but after returning to recess quarters at Dígha there were a few cases of cholera and dysentery.

233. *Topographical Survey.*—In accordance with the procedure laid down in 1896-97, a topographical survey on the 16-inch scale was made of all villages lying in the Ganges, Gogra, and Gandak rivers, which did not come under the provisions of the Bengal Tenancy Act.

The survey has been mapped on 105 sheets. All village sites have been surveyed in blocks and all topographical features of any importance have been accurately mapped with a view to their being utilized in the compilation of the standard sheets.

The check survey comprises 260 linear miles of *partál* which gives an average of 4·57 linear miles of *partál* to each square mile of survey. The cost-rate is R13 per square mile.

The areas of work completed will be found in the subjoined tabular statement.

District.	Traverse Survey.		Cadastral Survey, 16 inches=1 mile and Record writing.			Topographical Survey 16 inches=1 mile.
	Number of Stations.	Area in square miles	Number of Villages.	Number of Fields.	Area in square miles.	Area in square miles.
Sáran . .	7,745	267	1,066	1,157,451	548	57

234. *Badar Establishment.*—The *badar* section of the Bengal Drawing Office was transferred to North Bihar, each cadastral camp being allowed to entertain a small *badar* establishment which, during the season, undertook the completion of the *badars* of 1897-98.

The work completed was as follows: 877 villages, 1,180,871 fields with an area of 555·27 square miles. In the above area only *badars* effecting 582 villages were submitted by the Settlement Department. In these villages only 3,309 fields required corrections.

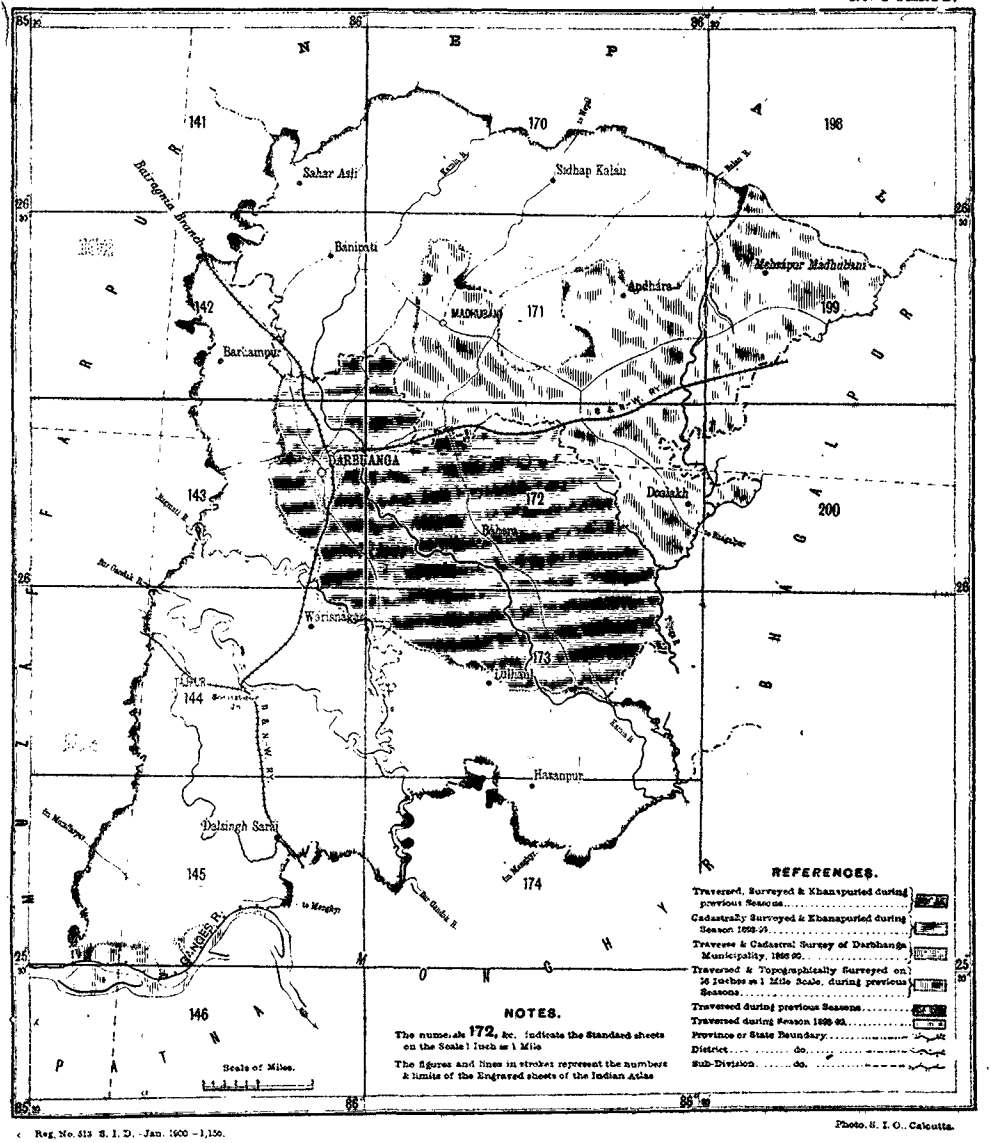
Darbhanga District.

235. *Traverse Survey.*—As the traverse survey in the Sáran district neared completion, and as the services of the sub-surveyors became available, they were moved across to Darbhanga. By the 1st of February the whole traverse section was employed in this district. The area completed contains 596

BENGAL SURVEY.

INDEX TO THE CADASTRAL SURVEY IN DISTRICT DARBHANGA.

1898-99. No. 4 PARTY.



Reg. No. 513 S. I. O. - Jan. 1900 - 1,150.

Photo. S. I. O., Calcutta.

No. 405-S. 1900.

villages and 618·72 square miles. In addition to the above, 31 blocks comprising an area of 6·96 square miles, was traversed in the Darbhanga Municipality. The area traversed was divided up into 3 main circuits, which were again sub-divided into 35 sub-circuits.

During the season under report, 13,573 new stations were embedded, of these 1,054 were marked by stone prisms, 9,749 by clay cylinders, and 583 by wooden pegs. In the survey of the Darbhanga Municipality, 11 were marked by stone prisms, 175 by iron pins, and 2,401 by clay cylinders. The temporary demarcation was found to be excellent. The health of the establishment was exceptionally good throughout the season.

236. *Cadastral survey and writing of Records.*—This section was under the supervision of Mr. C. S. Kmal, Extra Assistant Superintendent, assisted by Messrs. T. W. Babonau, E. G. Hardinge, Sub-Assistant Superintendents, and A. E. Le Franc and W. H. Babonau, Supervisors. The native establishment consisted of 4 head inspectors, 34 inspectors, 340 *amins*, and 340 *mirdhas*. In addition to the above there were 102 computers, draftsmen, tindals, etc.

The section commenced field work on the 3rd of November and after completing the entire programme (with the exception of 3 villages which were under water) and the Darbhanga Municipality, returned to recess quarters at Dígha on the 21st of April.

The programme consisted of the survey with records of all villages lying within *thána* Bahera, and a portion of *thána* Darbhanga. The area which comprised 916 villages, 1,131,264 fields, and 683·82 square miles was mapped on 1,337 sheets and on 655 additional sheets on the 64 inches=1 mile scale. The Darbhanga Municipality has been mapped on 94 sheets on the 64-inch scale.

The total number of linear miles of check run in the detail survey amounts to 1,136·91 by Europeans and 1,577·72 by inspectors. The average size of each field is ·38 of an acre. During the season 1·60 linear miles of independent *partál* were run to each square mile of survey. In village sites in order to test the accuracy of the survey, 965 blocks were re-surveyed and 1,532 *partál* lines run. The total number of entries in the *khasra* which were checked by European officers, amounted to 7,576 and by inspectors to 283,581, which gives an incidence of 26 per cent. on the total number of fields *khánápuried*. The demarcation of village boundaries was fairly good. During the season the health of the establishment was excellent. There were four deaths from cholera and two from dysentery. Mr. W. H. Babonau, Supervisor, also died during recess from consumption.

The total expenditure incurred amounts to R1,01,535, of this sum R44,092 are debitable to detail survey, etc., and R57,443 to *khánápuri*, completion of records, etc. The resulting cost-rates being as follows:—

Detail survey R64 per square mile; *khánápuri*, etc., R84 per square mile.

The areas completed are given in the subjoined tabular statement:—

District.	Traverse Survey.		Cadastral Survey, 16 inches=1 mile and Record-writing.			Topographical Survey on 16 inches=1 mile Scale.
	Number of Stations.	Area in square miles.	Number of Villages.	Number of Fields.	Area in square miles.	Area in square miles.
Darbhanga.	13,584	619	916	1,131,264	684	*Nil.*

237. *Badar Establishment.*—A staff of 3 estimators and 3 draftsmen were employed on the attestation *badars* of 1897-98. The work which has been dealt with during the season is as follows:—

Villages 965, fields 110,808, and area 732·54 square miles. In this area *badars* effecting 4,411 fields contained in 590 villages were submitted by the Settlement Department.

SONTHAL PARGANAS DISTRICT.

238. *Traverse Survey.*—This section, which was under the supervision of Mr. E. F. Berkeley, assisted by Mr. W. Newland, commenced field operations early in December. The work carried out consisted of the traverse survey of 1,936 villages, comprising 726 square miles. The greater portion of the work consisted of a compact block of 525 square miles lying to the N.-W. of Naya Dumka. Field work was completed on the 1st June 1899, on which date the detachment moved into recess quarters at Naya Dumka. The demarcation was fairly good and was carried out by the headmen of villages. Considerable opposition was experienced from the inhabitants of Tappa Manihári, who amused themselves by uprooting theodolite stations. During the season the following marks were embedded :—stones 2,335, cylinders 3,881, and pegs 14,764. A considerable number of stones still remain to be embedded. This is due to—

(1) The number of stones required being under-estimated.
(2) On the arrival of the additional stones great difficulty was experienced in obtaining carts at Deoghur.

The health of the Establishment throughout the season was excellent. The total cost of the season's operations amounted to ₹32,693, which gives an incidence of ₹45 per square mile.

CHAMPÁRAN DISTRICT.

239. *Traverse and Topographical Survey.*—This detachment was in charge of Mr. C. S. Gasper, Sub-Assistant Superintendent.

The original programme was approximately 172 square miles, this was reduced to 125 square miles and again, owing to the entire establishment being laid up with fever, to 95 square miles. Field operations commenced on the 20th January 1899, and on the 20th of May the detachment returned to recess quarters at Dígha. The topographical survey on a scale of 2 inches=1 mile has been mapped on 17 field sections. Mr. C. S. Gasper was greatly hampered owing to his having to employ ordinary *amins* who know nothing about hill surveying. This necessitated a good deal of time in training them. The total cost of the season's operations amounted to ₹9,545, which gives an incidence of ₹100 per square mile.

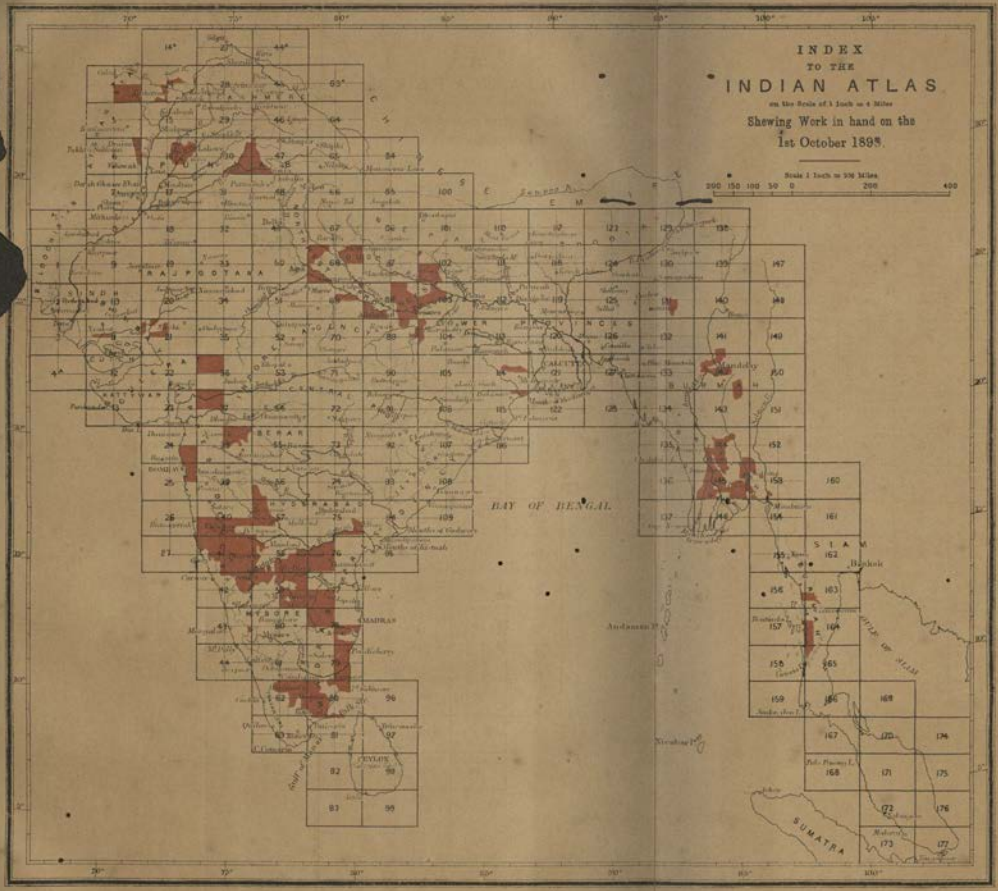
KACHNAR AND BANSKATTI MAHALS.

240. The survey of this dispute boundary was commenced in season 1893-94 under the supervision of Major (then Captain) G. B. Hodgson, but owing to none of the marks said to have been embedded by Sub-Surveyor Irfan Ali, being traceable, in 1897-98 Captain Crichton deputed Sub-Surveyor Sarju Pershad for the work, but apparently, the sub-surveyor misunderstood the orders sent to him. Mr. C. S. Gasper who was deputed to test the work during the season under report, reports, that all the stations laid down by Irfan Ali and Sarju Pershad have been marked with stones about 2′ to 3′ high; also with rocks and small stones piled round them. As Mr. Gasper's services were urgently required for the relaying of stations on the Nepál Frontier, he was recalled and the permanent marking of these stations postponed until 1899-1900.

NEPÁL FRONTIER BOUNDARY.

241. This work which was undertaken under the supervision of Mr. C. S. Gasper consisted of—

1. Examination and relaying any of the stations of the traverse survey done by Mr. E. F. Berkeley during the season 1897-98.
2. Refixing wooden posts Nos. 76 and 82 which had been washed away.
3. Removal of wooden posts from 67 to 71.
4. Survey of the Nuna river and refixing of wooden posts Nos. 23, 24, and 30.



Reg. No. 504 S. T. D.—Nov. 98.—100

Lahore, S. T. O., Calcutta.

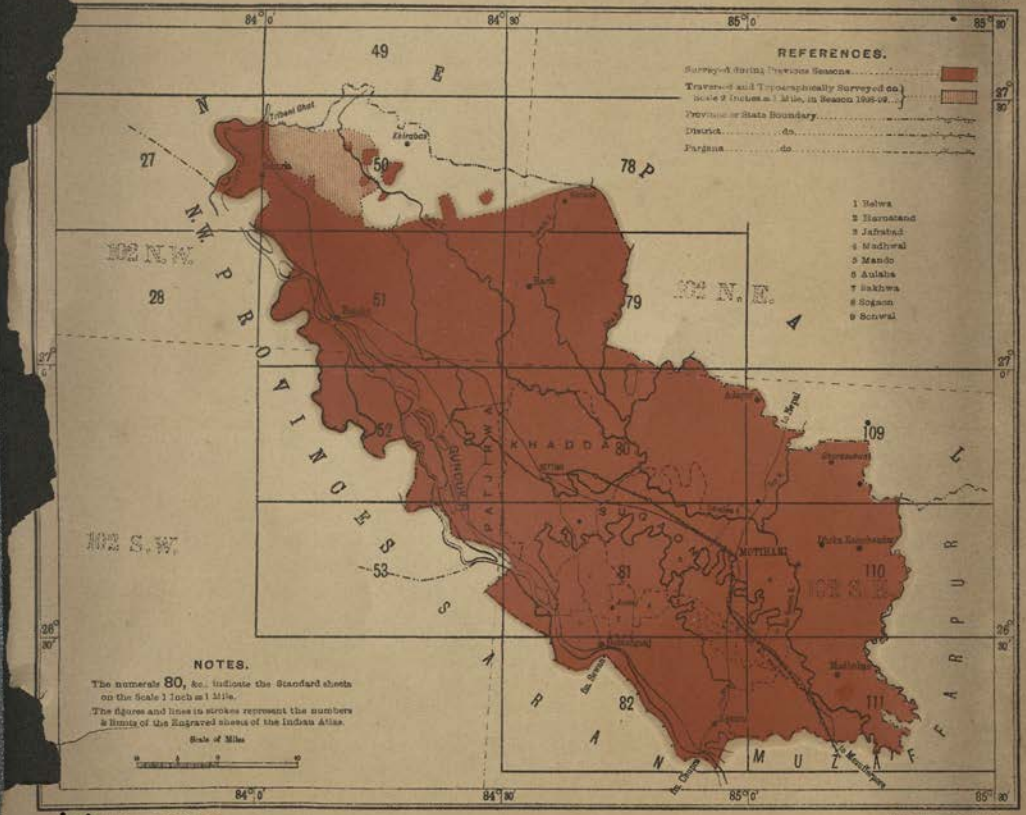
No. 407-S. 94.

BENGAL SURVEY.

INDEX TO THE CADASTRAL SURVEY IN DISTRICT CHAMPARAN.

98-99.

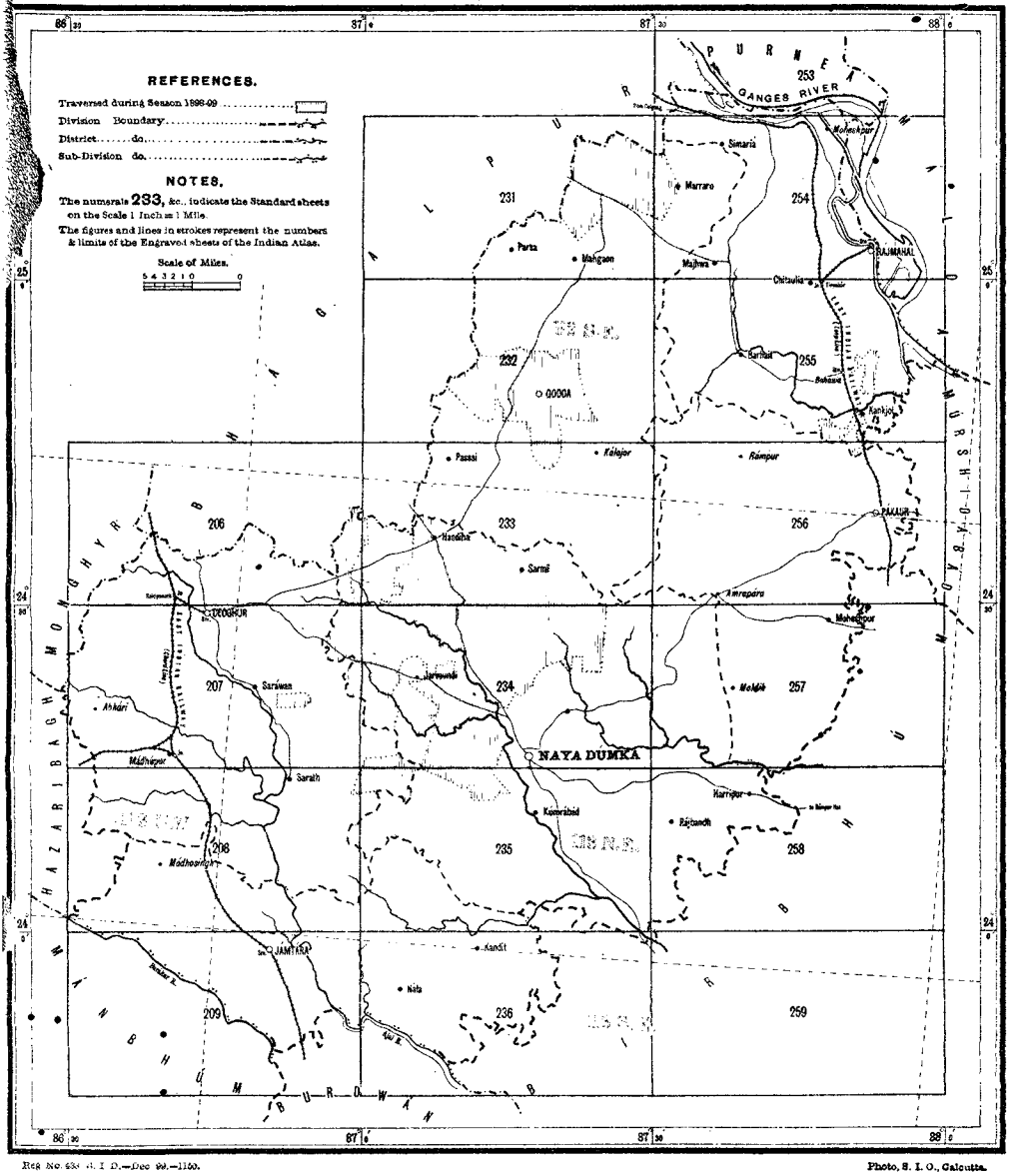
No. 4 PARTY.


REFERENCES.
Surveyed during Previous Seasons
Traversed and Topographically Surveyed on Scale 2 Inches = 1 Mile, in Season 1898-99.
Province or State Boundary
District do.
Pargana do.
1 Belwa
2 Harnatand
3 Jafratad
4 Madhwal
5 Mando
6 Aulaha
7 Sakhwa
8 Sogaon
9 Sonwal
49
50
51
52
53
78 P
79
80
81
82
109
110
111
27
28
N.W. PROVINCES
NEPAL
KHADDA
PARGANA
SURSUND
MOTIHARI
Tribeni Ghat
Ekhandi
Bettia
Ramnagar
Sursand
Adapur
Dhanauti
Dhaka Kalyanpur
Madhubani
Mahsi
Ramgarhwa
Bhitaha
Bagaha
Lauriya
Nandangarh
Areraj
Motihari
Kesaria
Piprakothi
Chakia
Sugauli
Harsidhi
Pakri
Belwa
Bhikhna Thori

BENGAL SURVEY.

INDEX TO THE TRAVERSE SURVEY IN DISTRICT SONTHAL PARGANAS.

1898-99. DETACHMENT.



Reg No. 633 S. I. D.—Dec 99.—1150.

Photo, S. I. O., Calcutta.

No. 610-S. 99.

BENGAL SURVEY.

INDEX TO THE CADASTRAL SURVEY IN DIST. MUZAFFARPUR.

1898-99. No. 4 PARTY.

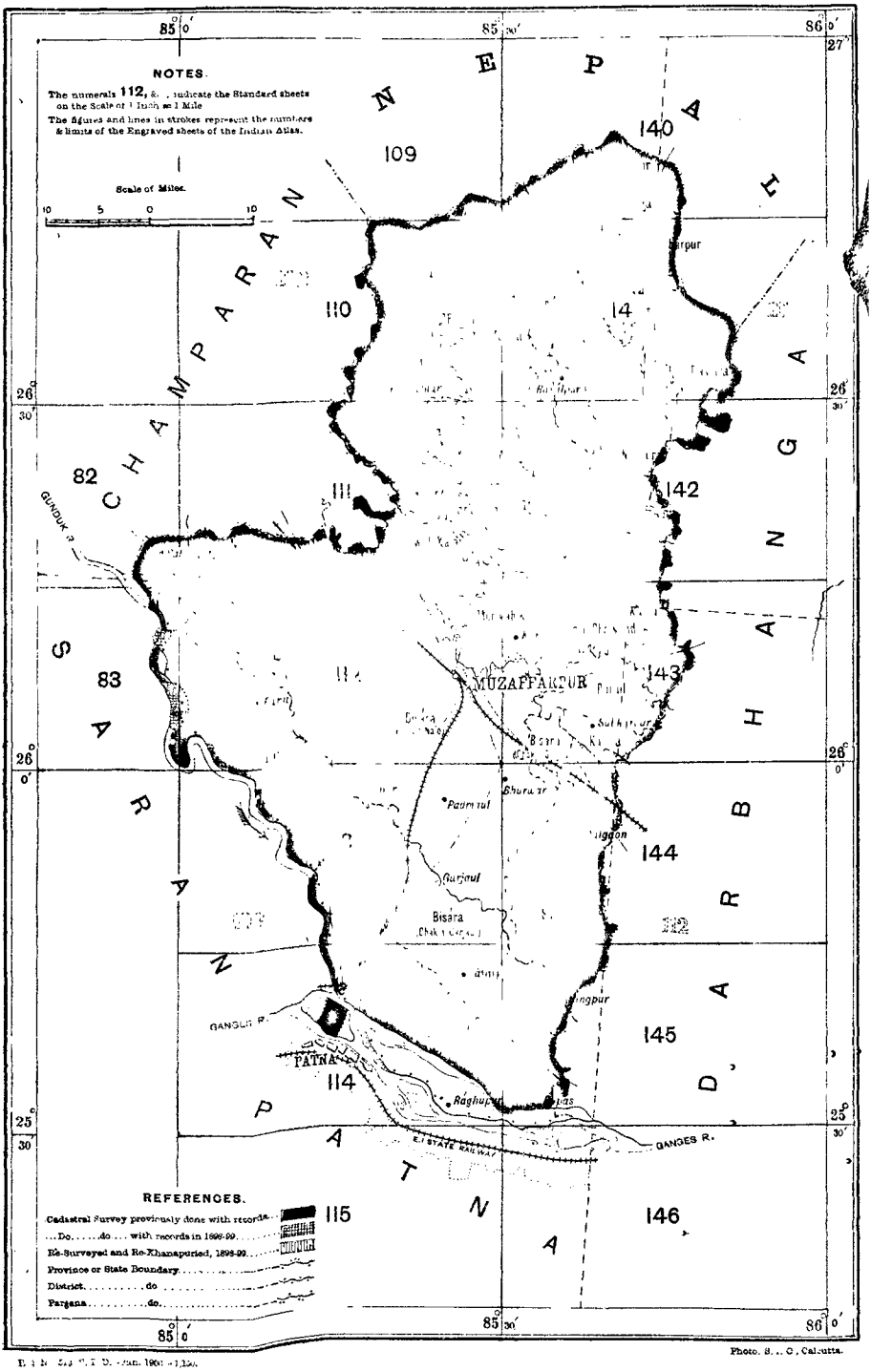


Photo. S. & C. Calcutta.

No. 404-S. 1900.

Arrangements having been made between the Nepálese representative and the Sub-divisional Officer of Supaul, Mr. C. S. Gasper was deputed by the Superintendent, Settlement Surveys, Bengal, to proceed to Bírpur. The work was commenced on the 13th of December. Out of the 14 stations embedded by Mr. E. F. Berkeley between pillars 11 and 14, 9 were found to be intact, while 5 had been washed away by the river. The relaying of these 5 was completed by the 17th December. The rest of the work on the Nepál Frontier was completed on the 4th of January and Mr. Gasper returned to head-quarters.

MISCELLANEOUS SURVEYS.

242. In addition to the foregoing surveys, the following tabular statement shows the various minor operations carried out by No. 4 Party in Bengal, during the year under report.

DISTRICT AND ESTATE.	Traverse Survey.	Cadastral Survey.	Record writing.	Topographical survey on 16-inch scale.	Topographical survey on 2-inch scale.	City survey on the 64-inch scale.
1	2	3	4	5	6	7
	Sq. m.	Sq. m.	Sq. m.	Sq. m.	Sq. m.	Sq. m.
Muzaffarpur Diára	...	2·65	2·65	...	...	...
Revision of Bazidpur Village	...	2·63	2·63	...	...	...
Darbhanga City	6·96	...	...	...	...	4·0
Chapra City	1·84	...	...	...	...	1·9
Revelganj City	...	...	...	2·00	...	...
Sháhabad Dumráon Ráj	...	25·86	25·86	...	...	...
Sháhabad Diára	...	...	...	25·08	...	...
Ballia Sáran	...	...	...	13·08	...	...
Patna Diára	...	29·33	29·33	10·61	...	...
Sháhabad Dumráon Ráj Diára	14·21	...	...	14·21	...	...
Revision of Babu Ganeshar Pershad's area	...	...	22·2	...	...	...
TOTAL.	23·01	60·47	82·67	64·98	...	5·9

243. According to the orders of the Bengal Government the programme for 1899-1900 is shown in the following table:—

DISTRICT.	Traverse.	Cadastral Survey with records.	TOPOGRAPHICAL SURVEY.		
			16-inch scale.	4-inch scale.	2-inch scale.
	Sq. m.	Sq. m.	Sq. m.	Sq. m.	Sq. m.
Darbhanga	...	941	...	...	...
Monghyr	655	...	...	...	...
Backergunge	600	...	...	...	...
Dáman-i-koh	700	...	...	...	..
Champáran	80	...	...	...	80
Nepál Boundary, Kachnar Mahal	Relaying Stations.		...	...	...
			...	...	...
Noákháli	50	...	...	50	...
Jauhi Village (Ballia)	7	7	...	...	...
TOTAL	2,092	948	...	50	80

N.B.—Captain Symonds reports well of all officers attached to No. 4 Party, especially of the services rendered by Messrs. A. W. Smart, C. S. Kraal, H. Dowman, E. F. Berkeley, and C. S. Gasper.

TOUNGOO AND MYINGYAN DISTRICTS, LOWER AND UPPER BURMA.

No. 7 Party.

244. Mr. T. E. M. Claudius was in charge of the party till relieved on 15th November 1898 by Mr. E. J. Jackson, who continued in charge till 10th April 1899, when he proceeded on 6 months and 21 days furlough, making over charge to Mr. E. G. Little, who held it for the remainder of the year.

Personnel.

Mr. T. E. M. Claudius, Extra Assistant Superintendent, 1st grade, in charge, till 14th November 1898.
Mr. E. J. Jackson, Superintendent, 1st grade, in charge, from 15th November 1898 to 10th April 1899.
Mr. E. G. Little, Extra Assistant Superintendent, 1st grade, in charge, from 11th April 1899.
Mr. J. Connor, Extra Assistant Superintendent, 3rd grade.
„ G. W. Jarbo, Extra Assistant Superintendent, 4th grade.
„ G. C. Swiney, Extra Assistant Superintendent, 4th grade, from 21st April up to 9th October 1899.
Mr. J. S. Swiney, Extra Assistant Superintendent, 4th grade.
„ C. W. Wilson, Extra Assistant Superintendent, 6th grade, from 1st January 1899.
Mr. W. J. Baker, Sub-Assistant Superintendent, 1st grade, till 20th September 1899.
Mr. W. Newland, Sub-Assistant Superintendent, 2nd grade, till 1st January 1899.

245. The cadastral survey of Upper Burma having of late years advanced too far ahead of settlement operations, it was decided to reduce the establishment and the outturn to about 800 square miles annually. In accordance with this decision two cadastral camps were formed in Lower Burma for the survey of the area remaining in the Toungoo district, and were placed in charge of Messrs. Jarbo and J. S. Swiney; Mr. Jarbo was helped by Mr. Wilson from the date he joined the party. Both the above camps as well as the head-quarters one were located at Toungoo during the field season. Mr. Little, assisted by Mr. Baker, had charge of the only cadastral camp in Upper Burma for the survey of the small area remaining in the Myingyan district, on the completion of which the camp returned to recess quarters at Mandalay, whilst Mr. Little proceeded to Toungoo to relieve Mr. Jackson of the charge of the party when that officer proceeded on furlough.

246. The two cadastral camps in Lower Burma took the field on 1st December 1898, and returned to recess quarters towards the latter end of May 1899. The cadastral camp in Upper Burma also started for the field on 1st December 1898, and closed operations on the 8th April 1899.

247. The programme, as revised, was to survey cadastrally the areas remaining in the Toungoo and Myingyan districts so as to complete them, and this has been done. No traverse work was undertaken during the season under report, there being a sufficiency prepared in advance of detail survey for next field season.

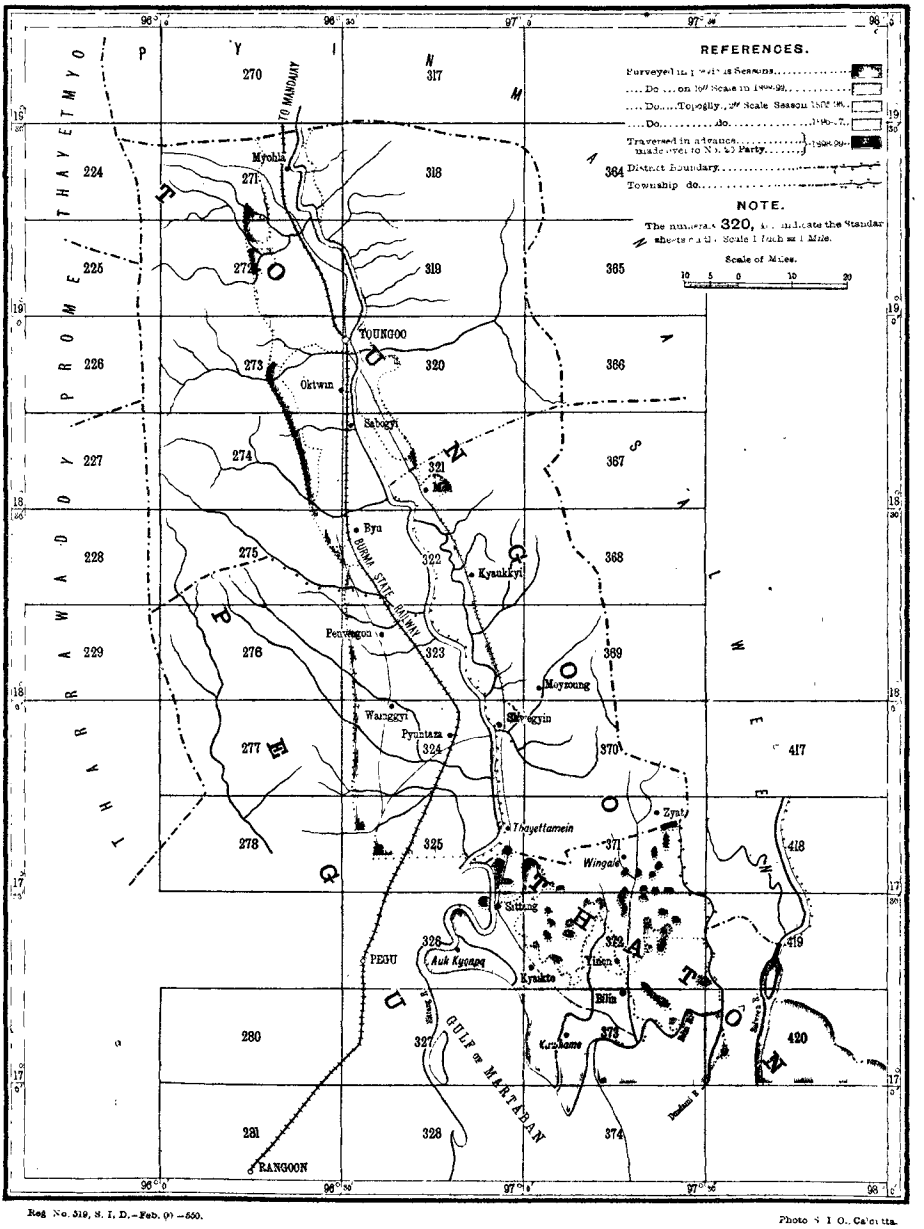
248. The following statement gives the season's outturn and cost-rates :—

District.	Cadastral Survey, 16 inches = 1 mile. Area in square miles.	Total cost.	Cost-rates per square mile.
		R a. p.	*R a. p.*
Toungoo, Lower Burma	665	90,406 2 10	135 15 2
Ditto, Revision Survey	46	9,945 14 7	216 3 5
Myingyan, Upper Burma	109	22,628 6 5	207 9 7
Arrears Establishment	...	58,114 10 7	...
Total	820	1,81,095 2 5	

BURMA SURVEY.

INDEX TO THE CADASTRAL SURVEY IN DISTS. THATÔN, PEGU, & TOUNGOO.

1898-99. No. 7 PARTY.



Reg No. 319, S. I. D.—Feb. 00—550.

Photo S. I. O., Calcutta.

No. 424-S. 00.

The high rates of the revision work in Toungoo and of the survey in Myingyan are accounted for by the scattered nature of the work and the smallness of the areas operated on.

249. The detail survey in the Toungoo district comprised 1,169 sheets, and was checked by 1,712 linear miles of *partál;* 928 miles of which were undertaken by inspectors, and the balance 784 miles, by European assistants and independent *partállers*. The average size of the field is 0·38 of an acre calculated on the cultivated area only, and the proportion of jungle to cultivation east of the Sittang river is as seven to one, and on the west four to one. In Myingyan the work was mapped on 163 sheets and checked by 441 linear miles of chain measurements including those done by inspectors, independent *partállers* and European agency. The average size of the field is 1·38 acres.

250. Owing to the survey having advanced so far ahead of settlement operations in Upper Burma, a vast quantity of cadastral maps have accumulated, which cannot be published till the settlement has been completed. Again, in some districts, the original surveys were carried out by circles, which were subsequently divided up into *kwins*, entailing renumbering of the fields and re-drawing of the whole of the work together with the preparation of new Field area statements. In many districts all holdings had been surveyed and numbered; subsequently it was ruled that holdings, being of a temporary nature, should not have been surveyed, thus necessitating the re-drawing, retracing, and recasting the area statements of all such work. Numerous tracings and copies of Field area statements (sometimes in duplicate) have also to be supplied to Settlement Officers from time to time, and continuous corrections and alterations have to be made on the original maps, due to revision surveys by local agency as the settlement work progresses.

In addition to the preparation and completion of the 16-inch cadastral maps and Field area statements, the party was expected to compile 2-inch reductions of all cadastral surveys, for incorporation in the standard sheets of the Province.

It was found impossible to cope with all this amount of mapping and miscellaneous work, which has accumulated since 1892-93, without forming a separate establishment of draftsmen and others to deal with it. An establishment was therefore created for the purpose during the year under report, and supervised by Mr. J. Connor, and the following statements show the extent of this arrear mapping, and the progress that has been made in clearing it off:—

CADASTRAL SURVEY MAPPING—SCALE 16 INCHES=1 MILE.

DISTRICT.	Sheets submitted for publication previous to 30th September 1898.	Sheets submitted for publication during 1898-99.	Sheets remaining in hand, awaiting settlement operations.
Meiktila	1,825	21	*Nil.*
Shwebo and Yeu . . .	...	2,796	757
Upper Chindwin . . .	...	...	790
Katha	146	1,459	*Nil.*
Yamèthin	...	...	2,407
Myingyan	...	...	3,964
Minbu	...	...	384
Lower Chindwin . . .	...	...	501
Magwe	...	...	2,554
TOTAL . .	1,971	4,276	11,357

STANDARD SHEET MAPPING—2-INCH REDUCTIONS.

DISTRICT.	Sheets submitted for publication previous to 30th September 1898.	Sheets submitted for publication during 1898-99.	Sheets remaining in hand.
Meiktila	...	24	*Nil.*
Shwebo and Yeu	...	...	70
Upper Chindwin	...	...	59
Katha	...	...	51
Yamèthin	...	36	*Nil.*
Myingyan	...	...	38
Minbu	...	...	20
Lower Chindwin	...	...	11
Magwe	...	...	47
TOTAL	...	60	*296

In addition to the above, 1,979 tracings of 16-inch maps and 96 tracings of 2-inch reductions have been prepared and submitted to Settlement Officers.

251. The country to the east of the Sittang river in the Toungoo district is low and covered with *jheels* and swamps, having narrow strips of cultivation running along their edges, whilst about 49 square miles of country situated to the west of Dinnya-wadi and Yegyi Circles on the opposite side of the river is full of ravines, and hills ranging from 100 to 500 feet high, and sparsely cultivated. Most of the country under survey in the Toungoo district during the season under report, is only now being opened out, judging from the numerous indications of intended extensions. Many of the village sites along the Sittang river were large and intricate, and the irregular strips of fallow ground between fields, being covered with high grass, rendered the work very laborious.

The area surveyed in Myingyan this season contains scattered patches of wet cultivation, but the greater part of the district is rough and broken up into low undulating hills covered with thorny jungle interspersed with ill-defined upland cultivation.

252. No complaints were received regarding demarcation, which seems to have been well done, especially in Lower Burma.

253. The establishments both in Lower and Upper Burma kept in fairly good health, and only three deaths occurred.

254. The party was inspected on the 9th, 10th, and 11th December in the field by the Deputy Surveyor-General.

255. All the tracings and area statements of the season's work have been completed and submitted to the Settlement Department before the commencement of the field season.

256. The programme for the coming season comprises :—

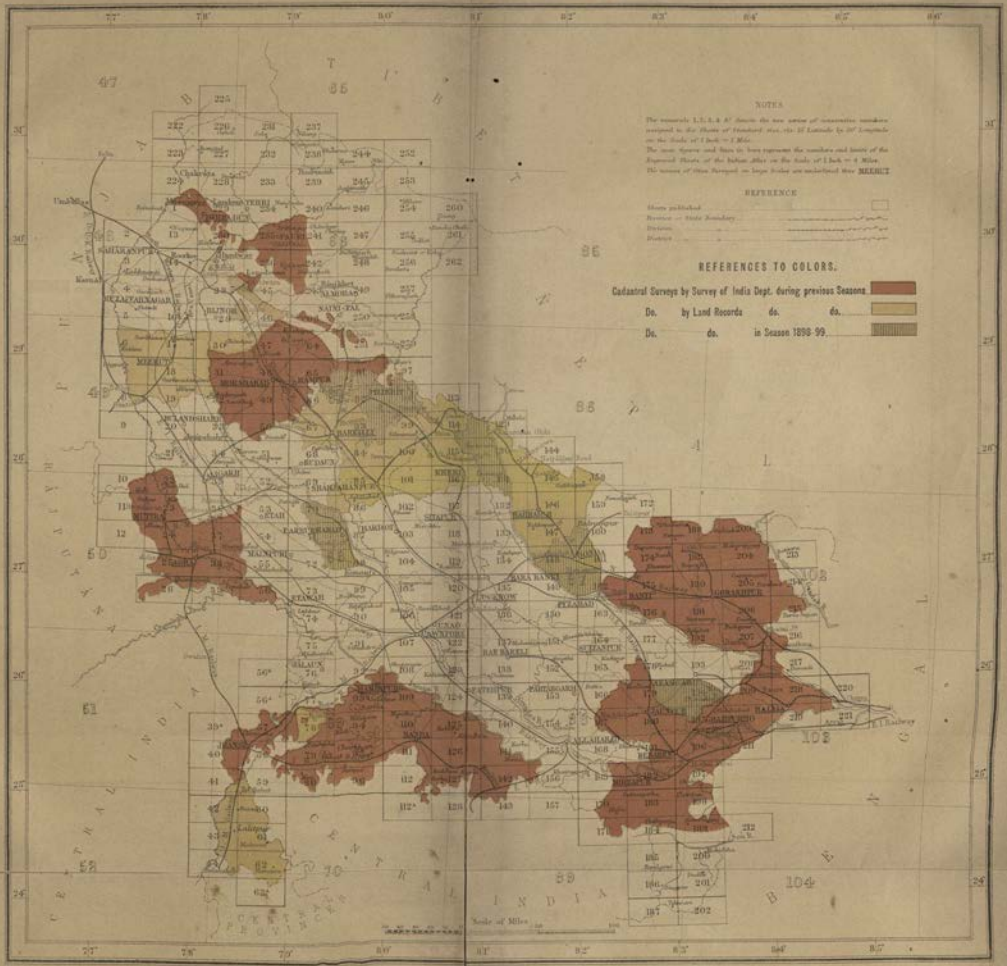
TRAVERSING.		CADASTRAL SURVEY.		REMARKS.
Area in square miles.	District.	Area in square miles.	District.	
790	Lower Chindwin	762	Lower Chindwin	...
...	...	...	Katha	Re-survey five villages.
...	...	152	Bawni (Toungoo)	...
...	...	?	Toungoo town and civil station.	Large scale, 64 inches = 1 mile.

* These are not all complete sheets.

NOTE.—The officer in charge reports that all the assistants have worked well, whilst Messrs. Connor, Jarbo, and J. S. Swiney are deserving of special mention. Of the native establishment Bhagobatti Charan Chakarbatti, Head writer, has, as usual, done excellent work, and most of the others have given satisfaction.

N. W. P. & OUDH SURVEY.

INDEX TO THE CADASTRAL SURVEY IN N. W. P. & OUDH.


NOTES
REFERENCE
REFERENCES TO COLORS.
Cadastral Surveys by Survey of India Dept. during previous Seasons
Do. by Land Records do. do.
Do. do. in Season 1898-99
Scale of Miles

Litho., S. I. O., Calcutta.

NORTH-WESTERN PROVINCES AND OUDH.

257. During the season under report the revision of village maps and records was completed in districts Bareilly, Kheri, and the hill *parganas* of Naini Tal, continued in Gonda and commenced in Farrukhabad, Azamgarh, and Pilibhít.

Personnel.

Mr. G. B. Scott, Superintendent.
„ T. F. Freeman, Deputy Collector, on survey duty.
Mr. L. F. Berkeley, Extra Assistant Superintendent, 6th grade.
Mr. P. C. H. Smart, Extra Assistant Superintendent, 6th grade.
Mr. O. D. Smart, Extra Assistant Superintendent, 6th grade.
Mr. N. Bedford, Extra Assistant Superintendent, 6th grade.
Mr. W. Skilling, Sub-Assistant Superintendent, 1st grade.
Mr. F. B. Powell, Sub-Assistant Superintendent, 1st grade.
Mr. C. H. G. Johnson, Sub-Assistant Superintendent, 1st grade.
Mr. G. Rae, Sub-Assistant Superintendent, 1st grade.
Mr. J. H. Murphy, Sub-Assistant Superintendent, 1st grade.

258. The total area surveyed was 3,314 square miles, the number of villages 4,376 and of fields 41,88,949. Of these the record writing in the field was completed of 4,338 villages containing 39,91,364 fields. The average size of the fields ranged from ·1 of an acre in Azamgarh (omitting Naini Tal as exceptional) to 1·6 in Kheri. The total number of *patwáris* in the tracts surveyed was 1,720, of whom 1,418 or 82 per cent. qualified and completed the survey and records of some or all of the villages in their circles. Of these, who from old age or other physical incapacity, were unfitted for survey work, the greater number provided substitutes in the person of their own heirs, or other relatives, and a few substitutes were appointed by survey officers with consent of the district officers. In addition 59 *Kanungos* and 263 *Umedwar* (candidate) *Kanungos*, sent for training by the Officers of other districts, were trained, and the greater number qualified and assisted in survey work, also 18 scholars from the Agricultural School, Cawnpore. The average daily outturn by *patwáris* ranged from 4 to 10 acres of survey in December and January, rising to 20 acres in the later months of the year and 42 fields of record writing.

259. No village plan was passed till it had been carefully checked, first by the Inspector of the circle, and after completion of survey and deposit of the plan in office, by "independent *partállers*." These are native surveyors employed exclusively in running check lines over completed villages, having no access to the plans, and registering details in field books which are plotted in office and compared with field sheets by the survey officers. All plans, which on application of these tests, were found incorrect were rejected and re-surveyed. The total area thus rejected only covered about 10 square miles. This does not of course include small portions of sheets rejected while work was in progress. The average length of check lines run by Europeans on board plan was 289 linear miles, inspectors 6,932 linear miles, and by independent *partállers* 3,362 linear miles, giving an average of about 3 linear miles per square mile of survey. Of the records those of 6,63,799 fields or 12 per cent. were checked chiefly by inspectors. As these are attested by Deputy Collectors before settlement operations commence, there is not the same necessity for so large a percentage being checked by European Officers as was usual in the Survey of India Department, when records were passed on to settlement officers without further attestation. No *amins* were employed on survey work except in Naini Tal where there are no *patwáris*, and in a portion of the Farrukhabad district where the near expiry of old settlement rendered it necessary to complete the survey of the Káimganj and *sadar tahsils* in one year and in the alluvial tracts along the Ganges in Gonda. Some villages in Pilibhít, where annual settlements are made, and villages in the jungle, north of the Chaka river, were also surveyed by *amins* at the request of the Collector. The cultivation of these villages was scattered in dense jungle, and none but experienced surveyors could have done this work correctly, certainly not newly trained *patwáris*. The rest of the work being on the two years' system, the *patwáris* needed little or no assistance, according to the size of their circles, and where it was needed *Kanungos* and candidates fully met the want.

260. Cost rates on the two years' system must be in excess of those for work done on the one year system, owing to the large number of inspectors, and still more of *mirdahs* or chain men required over a double extent of country. On the other hand, the *patwáris* after two years are, as a rule, not only good

surveyors, but also good at record writing, area estimating, and drafting. Expenditure is largely increased also when the *patwáris* are called away from survey duties for long or frequent intervals, and to ensure the completion of records of certain areas *Moharrirs* have to be entertained to complete the work. This year owing to the necessity for reports on cattle, crops, etc., in connection with the threatened scarcity or famine, the *patwáris* were more often withdrawn from survey work even than in previous years. An examination of the records of attendance shows that every *patwári* was absent from survey work for an average of 3 months of the year, during which either the work had to remain unfinished, or when necessary, completed by outsiders at increased cost. This was specially necessary in Bareilly and Kheri, where the survey was completed and only records remained to complete, and in Farrukhabad where the papers of two *tahsils* were urgently needed for attestation this year.

261. Of boundary disputes, 259 were reported, most of which were settled on the ground with the aid of former settlement maps. A few are still unsettled and have been reported to the record officers.

262. Rewards for good work to *patwáris* amounted in all to R 374-13-1.

263. Record writing has been much facilitated and uniformity ensured by the issue of the "Rules of Procedure" by the Board of Revenue. In accordance with these rules the demarcation of soils is now left to settlement officers. *Khatauni* or holding slips are prepared in the field simultaneously with *khasras*, and *khataunis* prepared from them subsequently in office. The preparation of *jamabandis* has been discontinued. The survey of districts Bareilly, Kheri, and NainiTal having been completed, and the records made over to settlement officers, the permanent establishments of those parties have been transferred to Mainpuri, Etáwah, and Etah, respectively.

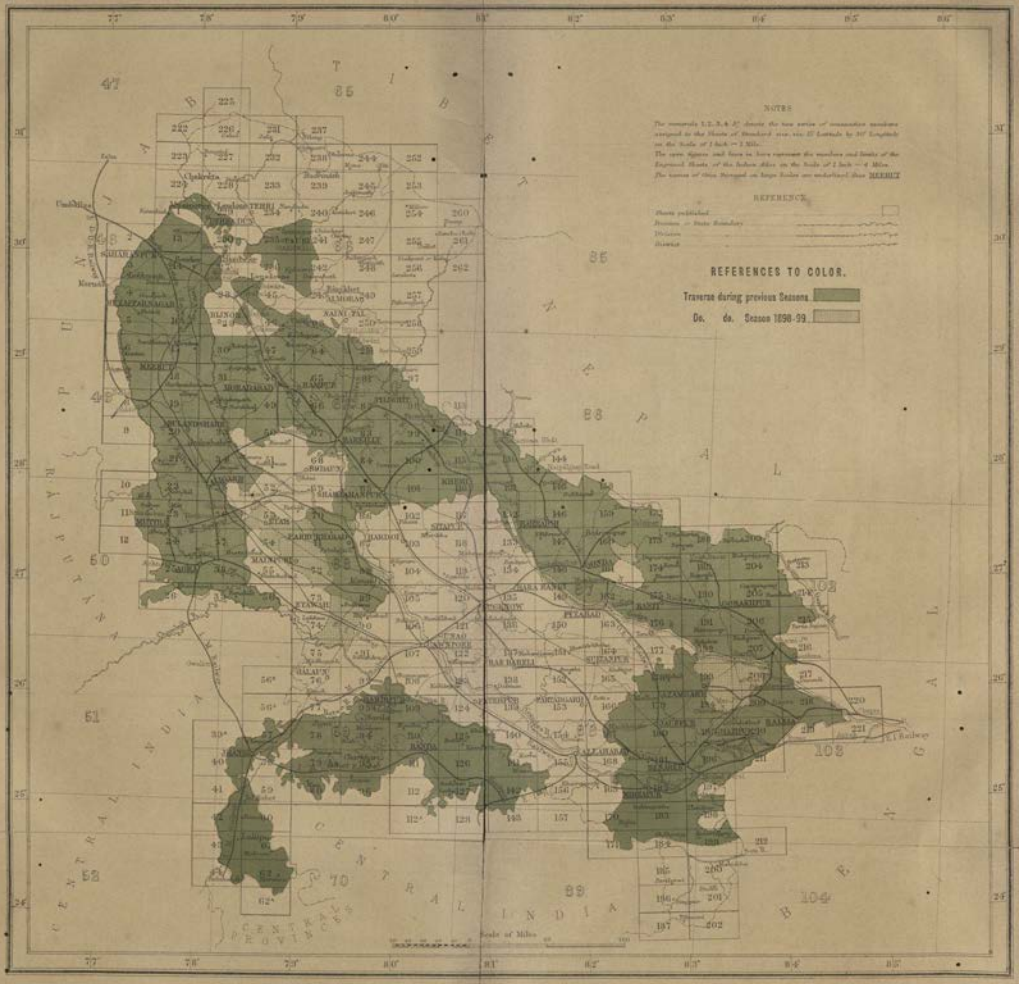
264. In district Bareilly only 344 square miles remained for survey, and in Kheri 284. When such small areas are supervised by the strength of a full camp, the cost per square mile must necessarily be heavy. In Bareilly, portion of the establishment was utilized in helping the Bísalpur section of Pilibhít, and the cost per square mile was therefore kept down to R69-2-8. This includes the cost of a small establishment employed in preparing plots for the Aligarh district. It was impossible to reduce expenditure, or increase the area to be done in Kheri. Moreover, the work remaining to be done was of the most difficult nature, consisting of numerous patches of cultivation scattered over a large area in heavy jungle and intersected by numerous water-courses. The cost for this year was R128 per square mile, but this rate does not apply to the entire area. The district is now completed, the area is 2,551 square miles, the cost from October 1895, R1,36,423-15-2, or an average of about R53-8-0 per square mile. The average cost per square mile for the year, of the remaining districts, is R52-12-4. This does not include cost of head-quarters establishment, which might add another R10 per square mile for expenditure under various heads.

265. The survey, and record writing of the cultivated area in the hill *parganas* of the Naini Tal district were completed. There is nothing to add to the remarks on this survey made in previous reports. The area surveyed this year was 21 square miles on the 64-inch scale, making the total surveyed in the district 101 square miles. Excluding carefully from this the area of all terraces and uncultivated land, the area under crop or lying fallow but held in occupation by tenants, is 61 square miles. The area according to previous papers in district office is 49 square miles, a difference of 12 square miles or 25 per cent. increase, although the actual cultivation appears rather to have diminished than increased since last settlement, owing to the tenants obtaining more valuable lands in the *Bhábar*. The cost of the 64-inch survey and record work, and of 4-inch index maps, (excluding cost of instruments transferred for use in other parties) was R426-6-9 per square mile. Mr. F. Powell, who has been in charge of this difficult work from the start, deserves credit for its success and full completion.

266. All the survey officers have worked with their usual zeal and ability. The work of Mr. Freeman (Deputy Collector, on survey duty) in Azamgarh was specially difficult and needed all his exceptional experience in survey and record work, together with his zeal and energy, to ensure correct results.

N. W. P. & OUDH SURVEY.

INDEX TO THE TRAVERSE SURVEY IN N. W. P. & OUDH.



Reg. No. 696, S. I. D.—Mar. 00.—250.

Litho., S. I. O., Calcutta.

267. The Superintendent visited the several districts under survey, and where time permitted personally examined the work of *patwáris* in the field, especially in Pilibhít and Farrukhabad, where work was commenced this year. He also completed the relaying of lost boundaries between Sháhjahánpur on one side, and Budaun, and Farrukhabad on the other, where the Rámganga and Ganges rivers had swept away all old land-marks over a large extent of country.

268. The Superintendent also personally supervised a training class of 12 junior civilians from 1st to 20th November. After surveying a small block of cultivation each, these officers were posted to surrounding districts to gain an insight into the system of survey, and assist survey officers by checking the work of *patwáris*. At this time of year the *patwáris* are, as a rule, only commencing work, and it is not therefore a seasonable time for observing the full working of a party. The training class will, during the coming season, be held in January.

269. In the month of December, having no competent assistant available for the work, the Superintendent personally refixed the sites of lost boundary pillars and selected others on the Nepál-Almora and Nepál-Naini Tal (Tarái) boundaries. In March and April, he ran check lines over numerous villages in the Agra and Muttra districts to test the present accuracy of the village maps. The districts having been cadastrally surveyed by the Survey of India Department, the original maps were of course correct. The Superintendent found few changes as a rule, and where field limits had been changed these had been correctly recorded on the maps, a re-survey was considered unnecessary. Mr. Johnson at the same time ran check lines across the Jálaun district and found the old maps as a rule much changed and at times seriously incorrect. It is believed a re-survey will be ordered of this district.

270. The Deputy Surveyor-General visited the Survey Camp at Gonda, Farrukhabad, and Bareilly in April and expressed his satisfaction with the systematic way in which the operations were being conducted.

TRAVERSE SURVEYS.

NORTH-WESTERN PROVINCES AND OUDH.

NOS. 2 AND 8 PARTIES.

271. During the year under report, charge of these parties was held by Mr. B. G. Gilbert-Cooper. Mr. W. S. Buttress was superannuated on 18th February. Mr. R. B. Smart's services were temporarily lent to the Punjab Government from 1st November until 1st April. Mr. J. Murphy was transferred to the Head-Quarters Offices, Calcutta, from 1st June, and Munshi Aulad Hossein, Babus Amar Sing, and Jagdamba Prasad were transferred to the survey training school at Dehra Dún, from 31st October.

Personnel.

Mr. B. G. Gilbert-Cooper, Deputy Superintendent, 1st grade, in charge.
Mr. W. S. Buttress, Extra Assistant Superintendent, 1st grade, from 1st October 1898 to 18th February 1899.
Mr. H. T. Hanby, Extra Assistant Superintendent, 1st grade, from 1st October 1898.
Mr. R. B. Smart, Extra Assistant Superintendent, 3rd grade, from 1st to 31st October 1898, and from 1st April 1899.
Mr. J. Mc Hatton, Extra Assistant Superintendent, 4th grade.
„ T. Shaw, „ „ „ 5th „
„ J. Murphy, „ „ „ 5th „ up to 31st May 1899.
Munshi Aulad Hossein, Sub-Assistant Superintendent, 2nd grade, up to 31st October 1898.
Mr. O. C. Ollenbach, Sub-Assistant Superintendent, 2nd grade.
Babu Amar Sing, „ „ 2nd „ up to 31st October 1898.
Mr. Jagdamba Prasad, „ „ „ „ up to 31st October 1898.
Mr. C. O'Donel, Sub-Assistant Superintendent, 3rd grade.
„ C. S. Littlewood, „ „ „
114 Sub-Surveyors, Computers, etc., etc.
1 Hospital Assistant.

272. The recess offices of the parties were closed at Mussooree on 25th October 1898, and field work started in districts, Farrukhabad, Mainpuri, and Azamgarh on the 1st November 1898, and in districts Etáwah, Etah, and Gonda, on the 1st December 1898, 14th January 1899, and 11th November 1898, respectively. The recess offices were re-opened at Mussooree on 1st May.

273. The programme sanctioned and the work actually carried out was as follows:—

(*a*) Completion of district Farrukhabad, exclusive of the bulk of alluvial tracts, comprising 166 square miles in *tahsils* Kanauj and 22 square miles of alluvial lands in *tahsil* Farrukhabad.

District Farrukhabad was commenced on 1st November, and completed by the end of the month. In this, as in the other districts that came under survey this year, it was decided, at the instance of the Superintendent, Land Records Surveys, to exclude from traverse operations all alluvial tracts, and only take them in hand during the same season as the cadastral survey by local agency; as previous experience had shown that in the interval between traverse and cadastral survey, amounting sometimes to more than a year, many of the survey stations were washed away, owing to fluvial action, necessitating their being re-laid at considerable extra expense.

(*b*) District Etáwah, about 700 square miles, in *tahsils* Bidhúna and Auraiya.

This district was commenced on 1st December, on completion of district Farrukhabad, and two whole *tahsils* Bidhúna and Auraiya, giving an area of 846·51 square miles, were completed in the order given, thus completing half the district. Some difficult country was here met with, lying along the rivers Jumna and Chambal, aggregating about 100 square miles, and consisting of formidable ravines, where it was almost impossible to use a chain.

(*c*) District Mainpuri, about 700 square miles, in *tahsils* Bhongaon and Mainpuri.

Work was commenced in this district on 1st November and closed on 13th January, and one whole *tahsil* Bhongaon and a portion of Mainpuri were completed, comprising an area of 694·67 square miles, and leaving a balance of about 1,000 square miles for future traverse. The country was open and easy.

(*d*) District Etah, 770·59 square miles, in *tahsils* Etah and Aliganj.

Work in this district was commenced on 14th January and closed on 6th April. *Tahsil* Etah was completed, and as much of *tahsil* Aliganj as was necessary to meet the requirements of the programme, comprising 770¾ square miles and leaving a balance of about 911 square miles to be traversed.

(*e*) Completion of district Azamgarh (exclusive of about 255 square miles of alluvial tracts), comprising 896 square miles, in *tahsils* Sagri and Muhammadabad.

Work in this district was commenced on 1st November and closed on 9th April. *Tahsils* Sagri and Muhammadabad were taken up, thus completing the district.

(*f*) District Gonda; alluvial tract touching on districts Fyzabad and Bara Banki, comprising an area of 242 square miles, and a similar tract in *pargana* Utraula with an area of 162 square miles.

The work in this district was started on 11th November and closed on 9th April. A balance of 338 square miles remains to be traversed in this district.

In addition to the above sanctioned programme, the following work was done for the local Government, at the request of the Superintendent, Land Records Surveys, the cost of which will be debited to the Government of the North-Western Provinces, *viz.*:—

(*a*) One Sub-Surveyor was deputed to district Kheri for 6½ months, to relay old stations or substitute new ones where they could not be found, also to traverse boundaries of newly-formed villages within forest areas and other miscellaneous work, at a cost of R742-11-5.

(*b*) Another Sub-Surveyor was similarly sent to district Pilibhít to survey disputed boundaries of villages bordering on the Government Forests, also to run supplementary sub-traverses and take up boundaries of villages, which during the traverse survey of the district, were for some reason either omitted or were found to be too far away from the traverse lines, at a cost of R183-12-0.

(*c*) A Sub-Surveyor was deputed, to district Bulandshahr, to survey a boundary dispute, at a cost of R127-0-10.

274. The average size in square miles of village circuits in the several districts traversed is as follows:—Farrukhabad 0·76, Etáwah 0·93, Mainpuri 1·17, Etah 1·06, Azamgarh 0·36, and Gonda, in *pargana* Utraula 0·78; and alluvial tracts 8·07.

275. Azimuth observations were taken at 462 points on main and sub-circuits in the season's work. With very few exceptions, as in the case of alluvial lands, main and sub-circuit traverses have been run along *pargana* and *tappa* boundaries. In alluvial tracts, the practice is, for the main circuits, to follow the first line of village boundaries above the high bank of the river.

276. The usual prism-headed stones obtained from Chunar, and baked clay cylinders, locally made, were used to mark the stations. The former were used as before, in marking (*a*) village trijunction points, where settlement marks were non-existent, (*b*) one satellite station at every trijunction, and (*c*) two consecutive stations between trijunctions a mile or more apart; cylinders were used for all other stations. The total number of stones used was 11,113 and cylinders 41,225. The number left unused, and which will be utilized next season, are, stones 5,771, cylinders 12,913. The cost of 16,477 stones purchased during the year under report, amounts to R4,326-2-6, including railway freight, and that of 50,131 clay cylinders, to R955-2-10, excluding carriage. The local carriage for both descriptions of marks, cost R3,026-4-1. The cost for cylinders this year is less, owing to the price paid per hundred being considerably less than in previous years.

277. Traverse charts of every district under survey have been prepared, showing the run of main and sub-circuits, with their trijunction points, azimuth, and Great Trigonometrical Survey stations, and a table showing their co-ordinate values from origin was also prepared.

278. The plotting done on various scales is as follows:—

	Scale.
2,656 villages and 121 river blocks on 55 sheets .	2 inches = 1 mile.
2,626 villages on 54 sheets	4 „ = 1 „
5,282 villages and 121 river blocks on 7,305 sheets,	16 „ = 1 „

279. The parties were divided into one Drawing Office and three Traverse Camps. The former together with a small topographical section, being in charge of Mr. T. Shaw, and the latter of Messrs. Buttress, Hanby, and McHatton; Mr. Smart taking Mr. Buttress' place on the retirement of that officer on 18th February 1899.

280. The field work of the topographical section, consisting of two native sub-surveyors, under Mr. O. C. Ollenbach, was commenced on 1st November and closed on 16th May. This section completed the survey on the scale of 2 inches to the mile, of the gaps left in *parganas* Lalitpur and Bánpur, of the Lalitpur sub-division of district Jhánsi, between the areas cadastrally surveyed, and which were scattered over an area of 860 square miles. The area surveyed was 30 square miles which completed Lalitpur. Absolute heights were observed this year, so that in conjunction with the heights given by the Forest Surveys, there are now heights above sea-level for every sheet of the Lalitpur sub-division. On the completion of Lalitpur, district Sháhjahánpur was taken up, and an area of 94 square miles of flat waste-lands in 46 *mauzas*, was completed on the 2-inch scale. In district Kheri the area surveyed on the 2-inch scale was 46 square miles, situated in seven *mauzas*, and scattered over several *parganas*. The surveys were, in the case of each district, based on the traverse stations fixed for the cadastral survey. The Drawing Office continued the compilation of standard geographical maps from recent cadastral surveys; but no fresh districts were taken up during the year. The mapping of districts Lalitpur and Sháhjahánpur was proceeded with, and that of the former district was practically finished by the 30th September. The whole of the cadastral maps of district Meerut received from the Land Records Survey Department have been reduced by pantagraph to the scale of 2 inches = 1 mile, and a comparison has been made with Colonel Wilkins' survey on the 2-inch scale made in 1874-75. From this it appears that additions and alterations will have to be made to two-thirds of the villages examined, and as these changes require draftsmen

skilled in the correction of original maps, it is considered that it will be preferable to construct entirely new maps of the Meerut district, rather than attempt to doctor up the old ones.

281. The following table shows the particulars of outturn and cost-rates for the season:—

District.	Area in square miles.	Total Cost.	Cost-rate per square mile.
Traversing.		*R a. p.*	*R a. p.*
Farrukhabad	188·18		
Etáwah	846·51		
Mainpuri	694·67		
Etah	770·59	99,734 5 11 (*a*)	26 3 10
Azamgarh	896·37		
Gonda	404·06		
	3,800·38		
Topographical.			
Lalitpur	30		
Sháhjahánpur	94	6,322 7 0	38 8 9
Kheri	40		
	164		
Miscellaneous work for Land Records			
Surveys	...	1,053 8 3 (*b*)	...
Drawing Office	...	13,447 0 2	...
	...	1,20,557 5 4	...

(*a*) Includes R8,286-0-5 for stone embedding.
(*b*) Debitable to North-Western Provinces Government. Includes 4 per cent. for cost of instruments.

282. As during the preceding seasons, the *mauza* was the unit in the system of traversing adopted; each *mauza* being sub-divided by traverses averaging half a mile apart, the object being to supply the Land Records Department with skeleton plots on the scale of 16 inches to the mile, with a sufficient number of fixed points to form a good basis, on which *patwáris* could do their detail surveys.

283. The health of the parties was throughout the field season excellent, there being few cases of sickness.

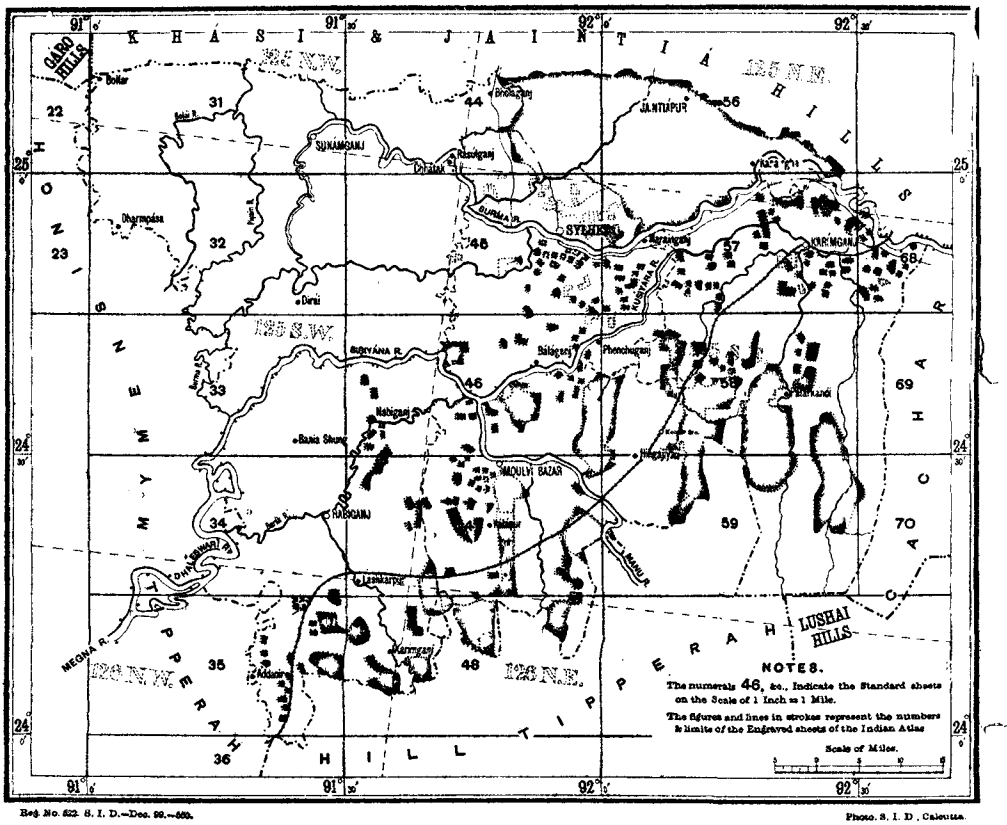
284. The boundaries in all districts were well demarcated, and the attendance of *patwáris* was good. Messrs. R. P. Dewhurst, Collector of Farrukhabad, J. M. Wright, Collector of Etáwah, W. R. Partridge, Collector of Mainpuri, P. U. Allen, Collector of Etah, E. Rogers, Collector of Azamgarh, and R. L. H. Clarke, Deputy Commissioner of Gonda, are to be thanked for the very prompt and cordial assistance always afforded by them during the progress of survey operations.

285. The parties were inspected in the field by Lieutenant-Colonel J. R. Hobday, Deputy Surveyor-General, and in recess quarters by Major-General C. Strahan, R.E., Surveyor-General, and again by Lieutenant-Colonel J. R. Hobday.*

* The officer in charge reports that Messrs. H. T. Hanby, R. B. Smart, J. McHatton, and T. Shaw have conducted their duties in a most satisfactory and able manner; and that Messrs. O. C. Ollenbach, C. O'Donel, and C. S. Littlewood also rendered good assistance. Of the Native establishment the names of Monohar Lall, Latifulla Khan, Dharanidhar Mookerjee, Gokul Chand, Mahadeo Ram, Basant Rai, Gouri Shanker, Sanat Kumar Chatterjee, Kanhya Lall, Enayetullah, and Krishna Prasad have been brought to special notice.

ASSAM SURVEY.

1899-99. **INDEX TO THE CADASTRAL SURVEY IN DIST. SYLHET.** No. 6 PARTY


KHASI & JAINTIA HILLS
GARO HILLS
SYLHET
SUNAMGANJ
JAINTIAPUR
KARIMGANJ
HABIGANJ
MAULVI BAZAR
LUSHAI HILLS
MEGNA R.
NOTES.
The numerals 46, &c., Indicate the Standard sheets on the Scale of 1 Inch = 1 Mile.
The figures and lines in strokes represent the numbers & limits of the Engraved sheets of the Indian Atlas
Scale of Miles.

Reg. No. 622. S. I. D.—Dec. 99.—500. Photo. S. I. D., Calcutta.

REFERENCES.

Previously Cadastrally Surveyed.....
Traversed previously.....
Traversed Ham lands Season 1898-99.....
Traversed Boundary of Grants .do.....
State.....Boundary.....
District.....do.....
Sub-Division...do.....

No. 609-S. 99.

No. 6 PARTY.

ASSAM SURVEY.

INDEX TO THE CADASTRAL & TOPOGRAPHICAL SURVEY IN DISTS. KAMRUP, DARANG, & NOWGONG, &c.

1896-99.

ASSAM.

No. 6 PARTY.

286. The charge of the party was held by Captain C. W. H. Symonds up to the 17th February 1899, when he was transferred and Mr. W. H. Penrose assumed charge.

Personnel.

Captain C. W. H. Symonds, Officiating Deputy Superintendent, 1st grade, in charge, up to the 17th February 1899.

Mr. W. H. Penrose, Extra Assistant Superintendent, 5th grade, in charge, from the 18th February 1899.

Mr. F. S. Bell, Sub-Assistant Superintendent, 1st grade.

25 permanent and 17 temporary Sub-Surveyors, Computers, etc.

287. The party left Shillong on the 22nd October 1898 and opened field office at Tezpur on the 1st November 1898. Field work was brought to a close in the Assam Valley on the 31st of May 1899, and in the Surma Valley on the 9th July 1899. Office re-opened in Recess Quarters at Shillong on the 10th June 1899.

288. Two traverse surveyors were deputed from Tezpur on the 11th November 1898 to complete the remaining areas in district Sylhet in the Surma Valley, and one Sub-Surveyor on the 9th November 1898 to execute a plane-table survey on the 2-inch scale, of the demarcation of certain boundaries in district Sylhet formerly under dispute and settled by a deed of compromise between the Maharaja of Tippera and the British Government.

289. The proposed programme and the areas actually completed are given in the following table:—

	Approximate area to be completed.	Area actually completed.	REMARKS.
	Sq. miles.	Sq. miles.	
Assam Valley.			In addition 185·8 linear miles of railway lines, open and under construction, falling in the 2-inch standard sheets, were traversed in the Assam Valley.
(1) 2-inch topographical survey	1,045·00	1,144·45	
(2) Traverse of villages for cadastral survey by local agency	30·00	56·04	
Surma Valley.			
(3) Traverse of *ilam* and waste-land grants in District Sylhet	23·40	22·54	
	1,098·40	1,223·03	
	Linear miles.	Linear miles.	
(4) Demarcation of boundaries between Sylhet and Hill Tippera in the Sátgaon, Dinarpur, and Balisira Hills on the 2-inch scale	35·18	35·18	

290. In the Assam Valley the area to be traversed was divided into two main and seven minor or river circuits. In the Sylhet district the areas being scattered, there were no main or sub-circuits. Each estate was traversed separately; the total number traversed being 58, with five sub-traverses. In the Assam Valley all co-ordinates for districts Sibságar and Lakhimpur were referred to the intersection of parallel 26° 30′ with the meridian of 94° 30′. In the Sylhet district the origin of the Jaintia Survey was preserved, *viz.*, the intersection of parallel 24° 30′ with the meridian of 92°. The traverse surveyors were provided with spare testing chains and these were again tested from time to time with the standard steel bars in camp, throughout the field season. In the Assam Valley the theodolite was set up at 6,120 stations and the aggregate length of the lines measured is 1,019 miles. In district Sylhet the theodolite was set up at 2,141 stations, and the aggregate length of the lines is 134 miles. Six stations of the Assam Valley Series and one of the Eastern Frontier Series have been connected with. The angular work was checked by azimuth observations, and the 2-inch detail survey by 110·73 linear miles of chaining, besides

examination *in situ*. In the Sylhet district the total number of new and old permanent marks (embedded by the Settlement Department) utilized as theodolite stations was 315. The remaining 1,826 stations were marked by wooden pegs with the usual mound and tree planted 5 feet to the magnetic north. In the Assam Valley the stations in the areas traversed for cadastral survey by local agency are marked as in Sylhet. The triple junctions of these villages will be permanently marked by the Settlement Department. In the traverse of the areas topographically surveyed on the 2-inch scale, pegs only were used.

291. A survey training class was opened on the 15th January 1899 at Tezpur under the supervision of Captain C. W. H. Symonds for the purpose of instructing the following officers :—

Mr. T. Emerson, Assistant Commissioner.
„ J. Donald, do.
Babu Uttam Chandra Dass, Extra Assistant Commissioner.
„ Lakhesvar Surma, Sub-Deputy Collector.
„ Ramkanta Barua do.
„ Janakinath Dass do.
Moulvie Abrar Hussain do.
Babu Benudhar Rajkwa do.
„ Ghanakanta Chaliha, Tehsildar.

These officers all passed after having done actual field surveying on the 16-inch scale aggregating 3,259 acres, or 5·10 square miles. This work was professionally tested by 14·07 linear miles of independent check lines. The school was closed on the 31st March 1899.

292. By the 30th September 1899 all the remaining 16-inch sheets of the cadastral survey of Cachar district were finally completed and sent to Calcutta for printing. The total number of these sheets is 1,354, falling in 15 standard 2-inch quarter sheets, in various stages of completion. Thirteen standard 2-inch quarter sheets of Jaintia and Pratábgarh, incorporating the recent cadastral survey of these tracts in Sylhet district, and which were previously reported as complete, were kept back on account of subsequent boundary surveys of the grants in the same district, and adjoining cadastral surveys in district Cachar. The work of incorporating the boundaries of these grants in 2-inch standard sheets, from 16-inch skeleton boundary plots previously supplied to the settlement officer and of which he has passed the boundaries, has been made over to the Assam Provincial Survey Detachment, together with four of these 2-inch standard sheets in which the new work falls, *viz.*, 45 N. E., 57 N. W., 58 N. E., and S. E. In the Assam Valley there are 127 standard 2-inch quarter sheets compiled from previous cadastral surveys and recent 2-inch topographical surveys. Twenty-four of these sheets have been completed and submitted for reduction and publication on the 1-inch scale. The remaining 103 sheets, all more or less incomplete, will be completed in the head-quarters' offices, Calcutta, by the end of May, but they will not all even then be ready for publication and will be eventually entirely completed in the drawing office of the Assam Provincial Survey Detachment as additional material becomes available.

293. On the 31st October this party ceases to exist, but from the 1st November 1899 sanction has been obtained for the retention of a Provincial Survey detachment under Mr. J. H. O'Donel, Extra Assistant Superintendent, to undertake all traverse operations in advance of local agency surveys, the topography of such areas as are required from time to time for the completion or revision of the standard sheets, and a drawing office for the compilation of topographical and other maps of the Province. The whole to be under the professional supervision of the Deputy Surveyor-General and the direct control of the Local Administration.

294. The health of the party was fairly good throughout the season, but a bad type of fever permanently disabled one and killed two computers on the temporary establishment. There were four deaths among the *khalásis*.

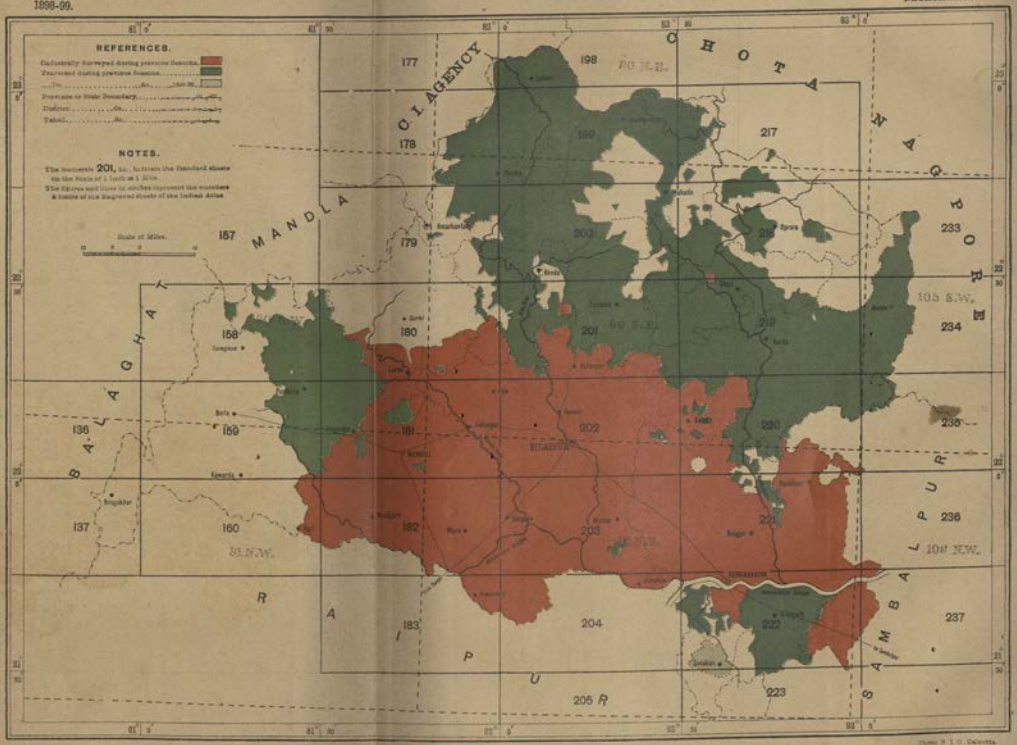
295. The Deputy Surveyor-General inspected the party both in the field at Tezpur in March and at Shillong in September.

Note.—With some few exceptions the members of the party, both European and Native, have worked well during the field season and in recess.

CENTRAL PROVINCES SURVEY.

INDEX TO THE TRAVERSE SURVEY IN DISTRICT BILASPUR.

1898-99. DETACHMENT.



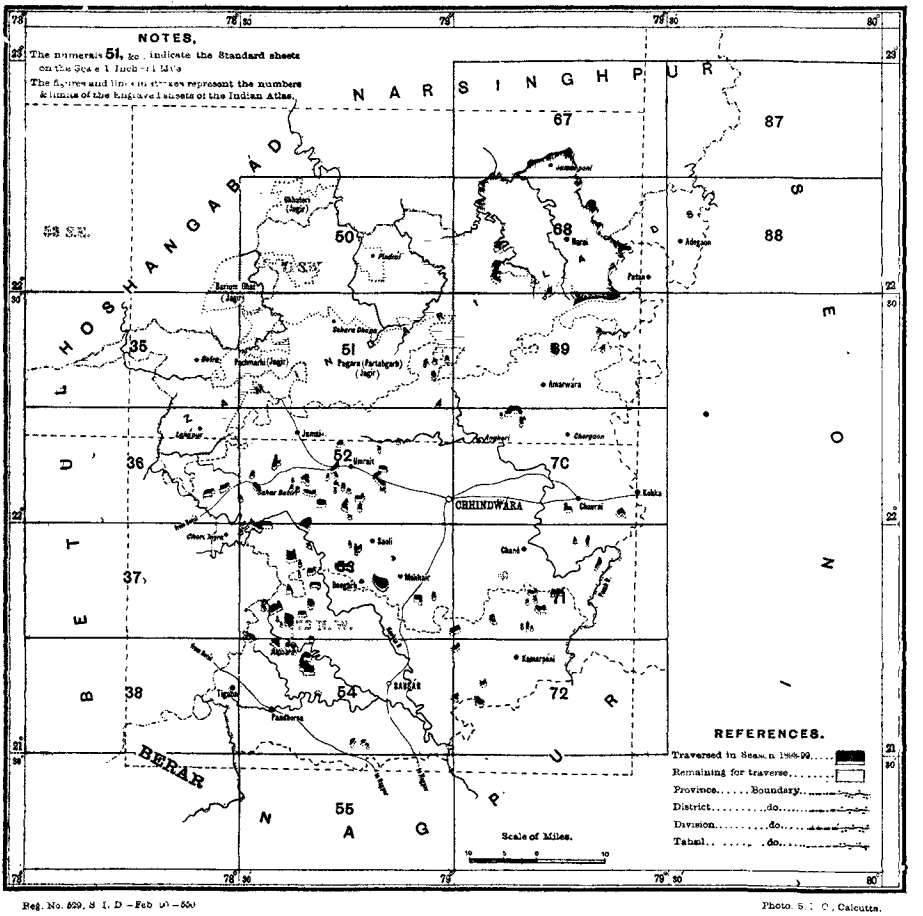
Survey of India Office, Calcutta.

No. 422-S. 00.

CENTRAL PROVINCES SURVEY.

INDEX TO THE TRAVERSE SURVEY IN DISTRICT CHHINDWARA.

1898-99. DETACHMENT.



Reg. No. 529, S. I. D.—Feb. 00—500

Photo. S. I. O., Calcutta.

No. 423-S. 00.

CENTRAL PROVINCES SURVEY.

INDEX TO THE TRAVERSE SURVEY IN DISTRICT BETUL.

1898-99. DETACHMENT.

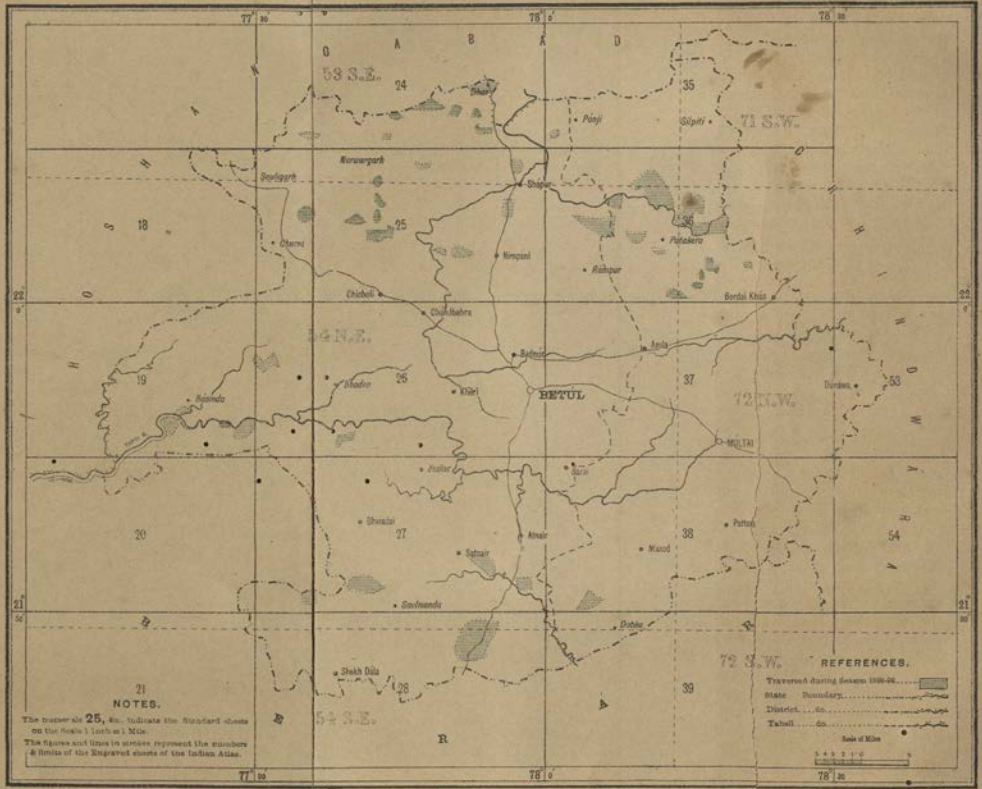


Photo. S. I. O., Calcutta.

No. 611-S. 99.

CENTRAL PROVINCES.

CENTRAL PROVINCES DETACHMENT.

296. Sanction was conveyed to the formation of this detachment, under orders of the Government of India, in their letter No. 1795, dated the 30th August 1898, for the conduct of traverse operations in the Central Provinces.

Personnel.

Mr. W. C. Price, Extra Assistant Superintendent, 1st grade.

8 Sub-Surveyors.	1 Draftsman.
6 Computers.	1 Writer.

297. The detachment assembled at Chhindwára on the 19th November 1898, and began traversing the excisions of that district on the 6th December, and of Betúl by the middle of January 1899, completing them, respectively, on 15th January and 31st March. From the 1st April to the first week of June the Chhindwára *jágirs* were traversed. The recess office was opened at Jubbulpore on the 12th June 1899.

With respect to the *locale* of operations, and the sequence in which they should be taken up, the detachment was placed under the direct orders of the Commissioner of Settlements and Agriculture, Central Provinces, to supply plots of *raiyatwári* excisions that were wanted promptly, irrespective of the distances apart, or districts in which they were needed, so that Settlement Officers could deal with them before they were transferred elsewhere. All traversing by local agency, with the prismatic compass and chain, a system which has been in vogue for many years past in these provinces, to supply data for the Land Record Surveys, was suspended.

298. The programme of work completed was as follows:—

(*a*) The traversing of 56 square miles of *raiyatwári* excisions, in the Chhindwára District.

(*b*) The traversing of 91 square miles of *raiyatwári* excisions, in the Betúl District.

(*c*) The supply of 16-inch plots of the above, in the field.

(*d*) The traversing of 300 square miles of villages, in the Chhindwára *jágirs*.

(*e*) The traversing of 31 square miles of Sonákhán estate and supply of 16-inch plots of 14 scattered waste-land grants, in the Biláspur District.

Chhindwára District Excisions.—The whole of the sub-surveyors were employed on the Chhindwára excisions, completing them by the middle of January. The work was very scattered and the blocks, as a rule, small and troublesome. Going from one to another took up much time, and the delays in obtaining men to point them out considerably inconvenienced the work.

Betúl District Excisions.—The excisions in Betúl were next urgently called for, and by the middle of January four sub-surveyors were sent there, the rest following soon after, each marching an average distance of 100 miles. The traversing was practically completed by the end of March. This country, especially the part worked in, is very hilly and rugged: the forest ranges, where the traversing lay, is difficult and unhealthy, thickly wooded and covered with high grass. Three different kinds of survey stations were found on the ground; one the Revenue, another the Forest Topographical, and a third, the local agency survey; and these three were undistinguishable from each other, and could not be identified by *patwáris* and other local officials. Imperial Revenue survey data were only available, and the stations had to be identified and pointed out by computers, who accompanied the sub-surveyors in the field.

Chhindwára jágirs.—When the Betúl work was complete, the sub-surveyors had to march distances of 150 to 200 miles each, to the Chhindwára *jágirs*, in the north-east corner of the district, taking up on the way excisions that had, owing to the faulty nature of the index maps and the ignorance of the local men, been wrongly traversed. These mistakes were detected on comparing the reduced plots with the forest survey maps. When the men got into the compact block of the *jágirs*, they had better assistance, and although the country was as difficult as they had worked in before, the progress was very rapid, and the two *jágirs* of Harrai and Gorpáni were completed before the field work closed.

Biláspur District.—One estate, named Sonákhán, belonging to the Cash Company, Calcutta, was traversed in part during the recess, and plots of 14

waste-land grants which had been surveyed before by No. 2 Party were supplied to the Settlement Officer.

299. The mark-stones embedded were 8,517 in number. Dressed and undressed stones of suitable size, with crosses cut on them, were locally obtained and firmly buried in the ground, leaving about a foot above the surface, and subsequently covered over with cairns of stones for their preservation and identification. The traverse lines followed closely the excision and village boundaries All the old boundary pillars that were suitably placed were utilised as traverse-stations.

300. The origin of the Chhindwára *jágir* traverses is the same as that adopted for the district before, *viz.*, Amliwára hill station of the Jubbulpore Meridional Series in latitude 22°-0′-53″·87 and longitude 79°-28′-54″·65.

301. The total expenditure for the year ending 30th September 1899 is R20,543, giving a cost-rate of R43 per square mile. These figures include heavy transfer, extra contingent, and transit charges, incidental to the organisation of a newly formed detachment; but this abnormally high cost-rate is chiefly due to the very scattered nature and small size of the blocks traversed, and therefore cannot be compared with the rates of former traverse operations of large compact areas in these provinces.

302. Throughout the season the health of the detachment was fairly good. In the early part sickness was rife, mostly malarial fever and bowel complaints, and in April influenza was prevalent. A *khalási* of the establishment was badly wounded by a wild boar whilst out at work in the Betúl district, and was a long time under medical treatment in hospital.

303. The Government forests included a number of villages containing small patches of culturable land. The original demarcation of the forest boundaries was effected in a haphazard way, and the present excisions included existing cultivation with a proportion of culturable land, separated with the object of giving good forest boundaries, and of making them conterminous with villages.

The attendance of *patwáris* and others to show the boundaries of the excisions was very unsatisfactory, causing considerable delay and trouble.

Guide maps were not given for the Chhindwára excisions but only village lists. Rough copies of the forest officer's maps on the 1-inch scale had to be made by the sub-surveyors for their guidance. The *jágir* index maps, made according to a sample supplied, were good. The Betúl tracings, forwarded by the Settlement Officer with his lists, were fair approximations.

304. With regard to the outturn of work the Settlement Commissioner reports as follows:—

"Having regard to the difficulties encountered in the nature of the country and the scattered character of the work, the progress seems to have been very satisfactory."

305. The programme for the coming field season consists of—

Continuation of the traversing of *jágirs* in Chhindwára and Hoshangabad; 203 square miles of the Charwa tract in Nimár, and the carrying out of any miscellaneous surveys which may be required by the Local Administration.

306. The detachment was inspected by the Deputy Surveyor-General, Revenue Branch, early in July, at recess quarters in Jubbulpore.*

GEODETIC.

ASTRONOMICAL LATITUDES.

No. 22 Party (Astronomical I).

Personnel.

Lieutenant E. A. Tandy, R.E., Officiating Deputy Superintendent, 2nd grade.
Babu Hanuman Prasad, Sub-Assistant Superintendent, 3rd grade.
Babu Govind Balwant Joshi, Computer, and one temporary computer.
One Hospital Assistant.

307. This party under Lieutenant E. A. Tandy, R.E., was employed on latitude operations on the East Coast Series. The party left Mussooree on the 3rd October 1898 and returned on the 24th May 1899.

* The officer in charge commends the work of the following men of the native establishment: Preonath Banerji, computer; C. Paupiah, writer; and Ram Narain, Nathu Khan, and Maula Baksh, sub-surveyors; the rest worked well and gave satisfaction.

308. The instrument used was Troughton and Simms Zenith telescope No. 1, which was this year for the first time mounted with two levels instead of one.

The following eight latitudes were taken, and a special interest attaches to the results, as, several stations being on the sea coast, they will afford valuable data in elucidating the question of the existence or otherwise of oceanic attraction :—

Station.	Number of pairs.	Number of observations.	Geodetic latitude. $=\lambda_c$	Astronomical latitudes and p. e. $=\lambda_o$	$\lambda_o-\lambda_c$ Apparent deviation of plumb-line.
			° ′ ″	° ′ ″	″
Vizagapatam base line N. end	50	102	18 1 2·91	18 0 56·60 ± 0·057 (2)	−6·31
Ráwal H. S.	46	92	18 32 9·22	18 32 4·64 ± 0·065	−4·58
Mal H. S.	49	98	18 47 16·97	88 47 6·75 ± 0·064	−10·22
Khundáboto H. S.	56	112	19 51 12·90	19 51 7·33 ± 0·050 (2)	−5·57
Cuttack Fort	56	127	20 29 0·68	20 28 52·03 ± 0·046	−8·65
Patna	50	132	21 47 20·83	21 47 17·35 ± 0·039 (3)	−3·48
Chandipur	50	101	21 26 36·99	21 26 33·93 ± 0·060	−3·06
Dariápur	52	107	21 47 27·95	21 47 28·80 ± 0·042	+0·85

309. Lieutenant Tandy states that these results can only be provisionally accepted, as an instrumental defect just recently brought to light may lead to the modification of some of them. The matter will be finally dealt with in his next annual report.

310. The persistent appearance of a northerly deviation of the plumb-line here shown is probably chiefly due to the attraction of the heavy masses of the Eastern Ghâts lying on the North-Western flank of the series. It is, however, impossible to make deductions from the results of one series by itself; such discussions must be postponed until the astronomical examination of the whole triangulation of India is more complete.

311. Owing to the addition of a second level to the instrument, Lieutenant Tandy has been able to undertake a series of investigations, which promises to be of very considerable interest. In connection with these investigations about two months were spent in Dehra Dún in experimenting with a system of level calibration which entailed nearly 4,000 observations of each of the two levels examined, and Lieutenant Tandy has submitted a very complete report of the work for publication in the Professional Papers of the Survey of India. This report is now in the Press, and may be further discussed on publication.

312. The reduction of this large number of observations, and the exhaustive examination of several important questions arising from the investigations, have, together with some other enquiries, which Lieutenant Tandy is conducting,

thrown a large amount of extra labour on the party, which has accordingly been strengthened by the addition of a fresh computer on probation and a sub-surveyor.

313. Portions of the country traversed by the party were very malarious, and it suffered considerably from this cause. The *daftari* of the party who had served for 20 years in the department died on his return journey at Dehra Dún, and one *khalási* was incapacitated from all further Government service, from the effects of malaria. The officer in charge had one sharp attack of fever in Cuttack. Otherwise the health of the party was good.

314. The party was inspected by Colonel St. G. C. Gore, R.E., Superintendent of Trigonometrical Surveys, on June 7th.

ASTRONOMICAL LATITUDES AND AZIMUTHS.

No. 23 PARTY (ASTRONOMICAL II).

Personnel.

Captain G. P. Lenox-Conyngham, R.E., Deputy Superintendent, 1st grade.
Babu Lal Singh, writer and recorder.
Sub-Surveyor F. Kerr.

315. There were no changes in the *personnel* of the party.

316. The party left recess quarters for the field on October 17th, 1898, and returned on April 18th, 1899.

317. The programme of work consisted of the determination of latitudes and azimuths at stations forming a group round Kaliánpur H. S., the origin of the Indian Survey.

The experience gained during the last season, when observations on this principle were carried out near Agra, led to a modification of the arrangement. No new stations were built but existing stations of the Principal Triangulation were selected, forming two quadrilaterals, an inner and an outer, round the old Observatory at Kaliánpur.

In so doing some sacrifice of symmetry was unavoidable, but the compensating advantages were considerable.

318. Observations for latitudes were taken at all the eight stations forming the quadrilaterals, and at the centre, that is at nine stations in all.

Observations for azimuth were made at eight stations, the ninth had been destroyed and Captain Lenox-Conyngham found it impossible to re-determine its original position with sufficient precision to render an azimuth observed there of value.

319. The quantity of observing got through the season was much greater than has been done before, and as a result the computations have only been completed with great difficulty, though assistance was given by the computing office at Dehra Dún. It has not therefore been possible up to the present time to analyse the results, or to draw any conclusion from them, they are merely tabulated without comment.

320. Should the system be extended to other places, it will probably be better to employ two observers, so that each may give undivided attention to one instrument in the field, and to the computation of his own observations in recess.

321. The officer in charge expresses his gratitude for ready and cordial assistance rendered by the officials of the Gwalior and Tonk States, within whose territories the whole of his work lay.

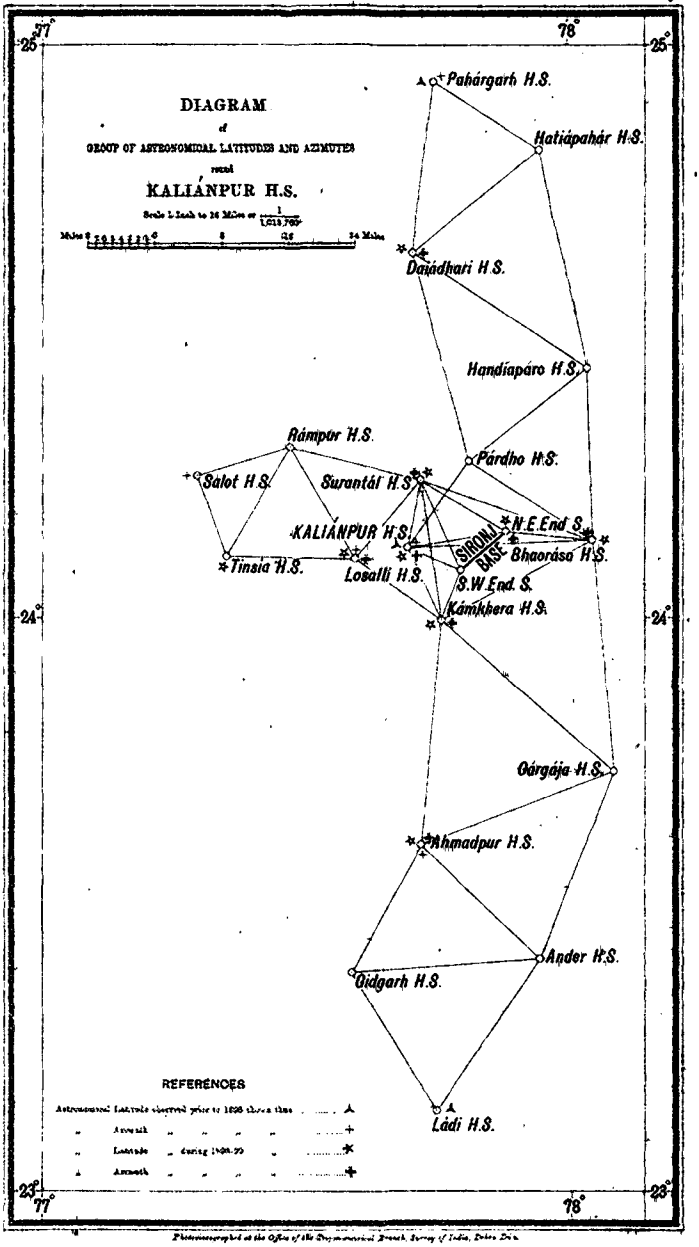
322. The health of the party was good throughout the season.

323. In the month of May, Captain Lenox-Conyngham took charge of the measurement of an experimental Base Line in Dehra Dún for instructional purposes.

324. The party was inspected by Colonel St. G. C. Gore, R.E., Superintendent of Trigonometrical Surveys, on June 6th.

Note.—Captain Lenox-Conyngham was satisfied with the work done by the members of the party.

Season 1898-99. No. 23 Party



Photozincographed at the Office of the Superintendent Branch, Survey of India, Dehra Dun.

Regr. No. D. 800, S. I. D. - July 99 - 344

No. 216-S. 99.

ABSTRACT OF RESULTS.

Azimuths.

Station.		Azimuths.	°	′	″	Observed —computed.	Station at other end of Ray.
Daiádhari	Observed		303	32	52·65		
	Computed				50·41	+2·24	Handiapáro.
Bháorása	Observed		95	12	39·38		
	Computed				38·08	+1·30	N.-E. end of Sironj Base.
N.-E. end of Sironj Base.	Observed		80	46	35·03		
	Computed				31·61	+3·42	Kaliánpur.
Kaliánpur	Observed		190	27	7·35		
	Adopted				5·1	+2·25	Súrantál.
Súrantál	Observed		10	27	43·86		
	Computed				40·46	+3·40	Kaliánpur.
Kámkhera	Observed		154	45	36·58		
	Computed				33·31	+1·27	Ditto.
Losalli	Observed		305	52	55·71		
	Computed				57·30	−1·59	Kámkhera.
Ahmadpur	Observed		185	10	56·14		
	Computed				53·91	+2·23	Ditto.

Latitudes.

Station.		Latitudes.	°	′	″	Observed —computed.	P. E. of observed Latitude.	Number of pairs of stars observed twice each.
						″	″	
Daiádhari	Observed		24	38	18·83	+1·26	±0·105	38
	Computed				17·57			
Bháorása	Observed		24	8	5·13	+1·40	±0·132	38
	Computed				3·73			
N.-E. end of Sironj Base.	Observed		24	8	55·46	+1·89	±0·084	44
	Computed				53·57			
Kaliánpur	Observed		24	7	10·46	−0·80	±0·083	44
	Adopted				11·26			
Súrantál	Observed		24	14	21·41	+0·99	±0·073	39
	Computed				20·42			
Kámkhera	Observed		23	59	42·95	−1·98	±0·068	42
	Computed				44·93			
Losalli	Observed		24	6	18·31	−0·86	±0·093	43
	Computed				19·17			
Tinsia	Observed		24	6	29·11	+1·14	±0·090	39
	Computed				27·97			
Ahmadpur	Observed		23	36	18·59	−2·29	±0·073	35
	Computed				20·88			

TIDAL AND LEVELLING OPERATIONS.

No. 25 PARTY.

325. The direction of these operations was in the hands of Lieutenant H. L. Crosthwait, R.E., throughout the year. The head-quarters of the party was removed from Poona to Dehra Dún in March.

Personnel.

Lieutenant H. L. Crosthwait R.E., Officiating Deputy Superintendent, 2nd grade, in charge, during the year.
Mr. G. Belcham, Extra Deputy Superintendent, 2nd grade.
„ E. J. Connor, Extra Assistant Superintendent, 3rd grade.
„ J. Bond, Extra Assistant Superintendent, 3rd grade.
„ J. F. Barker, Extra Assistant Superintendent, 6th grade.
Syed Zille Hasnain, Sub-Assistant Superintendent, 3rd grade.

Surveyors, etc.

Dhondu Vinayek, Vinayek Narayen, 2 Native artificers, 15 Recorders, and computers.

TIDAL OPERATIONS.

326. The automatic, recording of tidal curves by means of self-registering gauges, their reduction and the publication of Tide-Tables containing the predicted times and heights of High and Low water, have been continued during the year. The following is a list of stations at which tidal observations, have been and are still being taken: permanent stations are shown in italics.

	Station.	Automatic or Personal observations.	Date of commencement of observations.	Date of closing of observations.	No. of years of observations.	Remarks.
1	Suez	Automatic	1897	Still working.	2	
2	Perim	Ditto	1898	Ditto	1	
3	*Aden*	Ditto	1879	Ditto	19	
4	Muscat	Ditto	1893	1898	5	
5	Bushire	Ditto	1892	Still working.	6	
6	*Karáchi*	Ditto	1881	Ditto	18	
7	Hanstal	Ditto	1874	1875	1	
8	Navánár	Ditto	1874	1875	1	
9	Okha Point	Ditto	1874	1875	1	
10	Porbandar	Personal	1893	1894	2	
10A	„	Automatic	1898	Still working.	1	
11	Port Albert Victor (Káthiáwádar)	Personal	1881	1882	1	
11A	„ „ („)	Automatic	...	...	...	To be started.
12	Bhávnagar	Ditto	1889	1894	5	
13	*Bombay* (Apollo Bandar)	Ditto	1878	Still working.	21	
14	Bombay (Prince's Dock)	Ditto	1888	Ditto	11	
15	Mormugáo (Goa)	Ditto	1884	1889	5	
16	Kárwár	Ditto	1878	1883	5	
17	Beypore	Ditto	1878	1884	6	
18	Cochin	Ditto	1886	1892	6	
19	Tuticorin	Ditto	1888	1893	5	
20	Minicoy	Ditto	1891	1896	5	
21	Galle	Ditto	1884	1890	6	
22	Colombo	Ditto	1884	1890	6	
23	Trincomalee	Ditto	1890	1896	6	
24	Pámban Pass	Ditto	1878	1882	4	

	Station.	Automatic or Personal observations.	Date of commencement of observations.	Date of closing of observations.	No. of years of observations.	Remarks.
25	Negapatam	Automatic	1881	1888	6	The year 1884 85 is excluded.
26	*Madras*	Ditto	1880 Restarted 1895	1890 Still working	10 4 } 14	
27	Cocanada	Ditto	1886	1891	5	
28	Vizagapatam	Ditto	1879	1885	6	
29	False Point	Ditto	1881	1885	4	
30	Dubiat (Saugor Island)	Ditto	1881	1886	5	
31	Diamond Harbour	Ditto	1881	1886	5	
32	*Kidderpore*	Ditto	1881	Still working.	18	
33	Chittagong	Ditto	1886	1891	5	
34	Akyab	Ditto	1887	1892	5	
35	Diamond Island	Ditto	1895	Still working.	4	
36	Elephant Point	Ditto Ditto	1880 1884	1881 1888	1 5 } 6	
37	*Rangoon*	Ditto	1880	Still working.	19	
38	Amherst	Ditto	1880	1886	6	
39	Moulmein	Ditto	1880	1886	6	
40	Mergui	Ditto	1889	1894	5	
41	*Port Blair*	Ditto	1880	Still working.	19	

327. No tidal observatory was closed during the year under report. The observatory at Port Albert Victor will be opened during the ensuing field season, the building work having been completed; and that at Diamond Island will be closed.

328. In addition to the automatic registrations made during the year at the 13 stations enumerated above, personal tidal observations to graduated staves were taken at Bhávnagar, Tuticorin, Colombo, Chittagong, Akyab, and Moulmein, with the object of comparing the actual times and heights of high and low water with those predicted in the tide-tables. No such observations have been made at any of the other closed stations since the automatic registrations ceased, and it is not known if the predictions continue accurate. The scheme for checking tidal predictions at closed ports as noticed in last year's report, was sanctioned and put into operation during the past year.

Surveyor Dhondu Vinayek is at present engaged in erecting tide-poles at the ports which were selected for this purpose, *viz.*, Vizagapatam, Cocanada, Negapatam, and Cochin. It will be necessary to wait until all effects of the monsoon cease in order to get reliable observations at these ports.

329. All the tidal observatories in operation during the year were inspected, either by Lieutenant Crosthwait or by Mr. Belcham; portable meteorological instruments being taken by them for testing those working locally.

330. With one exception, Porbandar, the idal observatories have worked satisfactorily. At Porbandar registrations ceaset altogether from the 21st July, owing to the mouth of the pipe being covered dwith sand, brought in by the monsoon. This will be remedied during the ensuing field season.

331. The reduction of the tidal observations has been carried on steadily during the year: observations for the year 1898 at 13 tidal stations were reduced, and there are no arrears. The usual work in connection with the preparation of tide-tables for 1900 has been satisfactorily gone through; they will contain predictions, of high and low water times and heights, for 39 ports.

332. In the following statements, are summarised the percentage of error in the predicted times and heights of high and low water for the last nine years:—

PERCENTAGE OF ERROR IN PERIODICAL TIMES AND HEIGHTS AT OPEN COAST STATIONS FROM AUTOMATIC OBSERVATIONS.

YEAR.	No. of stations.	IN TIME.		IN HEIGHT.			
		Within 15 minutes of Actuals.		Within 8 inches of Actuals.		Within $\frac{1}{10}$ of mean range at Springs.	
		H. W.	L. W.	H. W.	L. W.	H. W.	L. W.
1890	13	69	70	95	93	91	91
1891	10	74	73	94	87	98	97
1892	8	75	74	91	85	98	98
1893	9	73	68	93	98	96	95
1894	10	65	62	95	92	97	95
1895	9	68	65	98	97	94	94
1896	9	71	70	97	97	97	93
1897	8	71	75	96	97	97	97
1898	9	74	70	96	96	95	95
Average of 9 years	9	71	70	95	94	96	95

PERCENTAGE OF ERROR IN PERIODICAL TIMES AND HEIGHTS AT RIVERAIN STATIONS FROM AUTOMATIC OBSERVATIONS.

YEAR.	No. of stations.	IN TIME.		IN HEIGHT.			
		Within 15 minutes of Actuals.		Within 8 inches of Actuals.		Within $\frac{1}{10}$ of mean range at Springs.	
		H. W.	L. W.	H. W.	L. W.	H. W.	L. W.
1890	3	53	55	64	63	90	86
1891	3	64	58	66	66	92	92
1892	2	61	60	72	65	94	95
1893	2	57	57	68	50	89	84
1894	2	56	55	66	42	88	80
1895	2	59	55	74	47	94	84
1896	2	56	55	63	42	87	74
1897	2	59	61	75	57	96	91
1898	2	53	59	71	61	90	91
Average of 9 years	2	58	57	69	54	91	86

333. A further investigation of the meteorological conditions, which prevail in the Persian Gulf, has been carried out. The records of wind velocity for three complete years have been analysed and compared with the errors of prediction for a corresponding period. It is conclusively proved that wind produces a considerable effect on tides in the Gulf. The diagrams prepared indicate that large errors of prediction are almost always accompanied by a high wind velocity. Though this is not an invariable rule, it is believed it would prove to be so were there sufficient observing stations, to judge of the wind's true force and direction over a large area. At present only the local record at Bushire is available. A slight variation from the normal in the strength of the wind produces a much larger effect in the Persian Gulf than at

other stations, due no doubt to the small depth of the sea. The large daily variations in mean sea-level at Bushire seems also to point to the abnormal influence of wind in the Persian Gulf. The wind exhibits no regular cycle, so far as can be judged from the three years under analysis. The following table shows the state of affairs as regards errors of prediction in times and heights:—

PERCENTAGE OF ERROR IN PREDICTED TIMES AND HEIGHTS AT BUSHIRE OPEN COAST STATION.

YEAR.	No. of stations.	IN TIME.		IN HEIGHT.			
		Within 15 minutes of Actuals.		Within 8 inches of Actuals.		Within $\frac{1}{10}$ of mean range at Springs.	
		H. W.	L. W.	H. W.	L. W.	H. W.	L. W.
1895		45	41	80	54	69	45
1896		58	44	77	70	73	62
1897		57	37	85	88	78	81
1898		67	47	84	82	74	72
Mean of 4 years.		57	42	82	74	74	65
Average at Open Coast Stations.	9	71	70	95	94	96	95

SPIRIT LEVELLING OPERATIONS.

334. The regular levelling operations, which had been suspended last year, to permit of the detachment being employed on revisionary triangulation in Assam, were again resumed and carried on by Mr. Bond. The programme for the year, was to complete the great line of levels from Vizagapatam to Allahabad, and then to carry a branch line from Katni along the Indian Midland Railway to Kethora and thence to the two ends of the Sironj Base Line, connecting *en route* trigonometrical stations of the Calcutta Longitudinal, Amua Meridional and Karára Meridional, Series.

335. The detachment left Poona on the 30th October 1898 and returned to head-quarters at Dehra Dún on the 4th June 1899, after completing the whole of the programme.

336. The total rises and falls amounted to 11,634 feet and the outturn to 378¼ miles of double levelling, in the course of which the instrument was set up at 3,727 stations and the heights of 33 embedded bench-marks, 331 permanent bench-marks, 94 Railway bench-marks, 11 Public Works Department bench-marks, and 8 Stations of the Great Trigonometrical Survey (including the ends of the Sironj Base Line) were determined.

337. During the next field season levelling operations will be commenced from Calcutta to Siliguri, which will be extended to Assam in after years. A detachment will also work on the branch lines of Eastern Bengal State Railway, Manihári Ghát, Achnera Ghát, Katihár-Bársoi, Bársoi-Kishanganj, Bársoi-Párbatipur, Porádaha-Faridpur; this latter work will be undertaken at the request and expense of the Railway in question.

338. In addition to the regular departmental work of the tidal and levelling party, a considerable amount of extra work had to be undertaken in order to furnish other departments and Local Governments with information applied for by them.*

*Lieutenant Crosthwait reports favourably of Messrs. Belcham and Connor, and Surveyor Dhondu Venayek of the Tidal Section, and of Mr. Barker and Munshi Syed Zille Hasnain employed with the levelling detachment. The staff of computers and mechanics is also well reported on.

Summary of the outturn of wo

Scale of Survey.	Number of Party.	Locale of field operations.		Triangulation: Instrument used. Diameter in inches.	Triangulation: Area in square miles.	Triangulation: Square miles to each point trigonometrically fixed.	Triangulation: Square miles to each height.	1st class triangulation: Stations fixed.	1st class triangulation: Triangular error in seconds.	1st class triangulation: Error per mile in feet.	Secondary: Stations fixed.	Secondary: Triangular error in seconds.	Secondary: Error per mile in feet.	Tertiary: Intersected points.	Tertiary: Error per mile in feet.	Spirit-level operations: Miles levelled over.	Spirit-level operations: Permanent bench-mark stones embedded.	Spirit-level operations: Trigonometrical stations
Inches to a mile. 64	4 Land Records Survey	Darbhanga City	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
"		Naini Tal	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Total	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
16	Central Provinces Det. 2 & 8	Farrukhabad	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Etáwah	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Mainpuri	5	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Etah	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Azamgarh	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Gonda	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Sáran	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	4	Darbhanga	10	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Muzaffarpur	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Patna	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Sháhabad	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Sonthal Parganas	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Ballia	15	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	7	Myingyan	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Toungoo	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Ditto Revisions	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Betúl Excisions	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Chhindwára Excisions	20	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Ditto Jagirs	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Biláspur Estate	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	10	Maymyo Town	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	17	Bombay Forests	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	Forest Branch.	Biláspur	25	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Chhindwára	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Nágpur and Wardha	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Chánda	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Seoni	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Sambalpur	30	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Saugor	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Bareilly	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Pilibhít	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Do. (Bísalpur Tahsil)	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	Land Records Survey.	Farrukhabad	35	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Kheri	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Azamgarh	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Gonda	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Total	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
12	15	Attock	...	6	21	0·14	0·14	...	...	...	11	13·9	0·22	146	0·55	...	...	...
8	17	Bombay Forests	40	7	415	...	...	...	...	...	193	11·5	0·28	1,468	0·41	...	...	...
	20	Burma Forests	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Total	...	...	415	...	...	...	...	...	193	...	...	1,468	...	...	...	...
6	15	Ráwalpindi	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Quetta Sor Range, Coal Mines.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	12	Sind	...	6	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Total	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
4	9 & 19	Kurnool	45	7 & 5	950	1·6	1·6	11	12·5	0·32	79	17·2	0·34	261	0·50	...	...	...
		Cuddapah																
		North Coimbatore																
		Salem																
		South Arcot																
		Madura	50															
	17	Bombay Forests	...	6	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Carried over	...	...	950	...	...	11	...	...	79	...	...	261	...	...	...	...

arties during the year 1898-99.

TRAVERSING.				DETAIL SURVEY.					RECORD-WRITING.			REMARKS.
Area in square miles.	Number of Stations at which the theodolite was set up.	Angular error per station in seconds.	Linear error per *mille*.	Area in square miles.	Plane-table fixings per square mile.	Linear miles of test lines.	Villages.	Average size of fields.	Area in square miles.	Villages.	Fields.	
7	3,189	...	...	4	...	5	37	...	4	37	32,000	
...	...	...	...	21	...	...	...	...	...	...	...	
7	3,189	...	...	25	...	5	37	...	4	37	32,000	
...	3,790	10	0·31	...	...	...	...	...	...	...	...	(a) Includes 57 square miles = 61 villages surveyed topographically on the 16-inch scale. 2 square miles = 3 villages of Revelganj city survey. 2 square miles = 8 villages = 12,990 holdings of Chapra city survey.
...	14,515	9	0·30	...	...	...	...	...	...	...	...	
5	10,950	0·5	0·13	...	...	...	...	...	...	...	...	
...	11,716	0·5	0·13	...	...	...	...	...	...	...	...	
...	19,028	11	0·03	...	...	...	...	...	...	...	...	
...	5,206	17	0·03	...	...	...	...	...	...	...	...	
...	7,745	...	...	609(a)	...	3,808	1,138(a)	0·30	550	1,074	1,170,441(a)	(b) Includes Revision of Khanapuri of 22 square miles = 24 villages = 23,462 fields.
10	13,584	...	...	684	...	2,715	916	0·38	706(b)	940(b)	1,154,726(b)	
...	...	...	...	5	...	14	4	...	5	4	4,435	(c) Includes 11 square miles = 11 villages, surveyed topographically on the 16-inch scale.
...	...	...	...	40(c)	...	162	21(c)	1·67	29	10	11,238	
...	184	...	...	65(d)	...	202	26(d)	1·81	26	8	9,133	(d) Includes 39 square miles = 18 villages surveyed topographically on the 16-inch scale.
...	26,818	...	...	...	...	...	...	...	...	...	...	
15	...	...	...	13(e)	...	38	5	...	...	...	...	(e) Topographical survey on the 16-inch scale.
...	...	...	...	109	...	441	93	1·38	...	...	50,422	
...	...	...	...	665	...	1,645	361	0·38(f)	...	...	312,684	(f) Of cultivated area only.
...	...	...	...	46	...	67	90				52,956	
91	2,225	7	0·9	...	...	...	...	...	...	...	...	
20	1,437	11	0·9	...	...	...	...	...	...	...	...	
...	4,602	5	1·0	...	...	...	...	...	...	...	...	
...	253	14	...	...	...	...	...	...	...	...	...	
...	...	...	...	8	...	...	...	...	...	...	...	
...	...	...	...	55	...	...	179	...	...	...	...	
25	...	...	...	15	85	...	...	...	...	...	...	
...	...	...	...	89	255	...	...	...	...	...	...	
...	...	...	...	10	Included in 4" work.				...	...	...	
...	...	...	...	36	Included in 4" work.				...	...	...	
...	...	...	...	86	145	...	...	...	...	...	...	
30	...	...	...	25	Included in 4" work.				...	...	...	
...	...	...	...	65	110	156	...	...	...	...	...	
...	...	...	...	345	...	1,550	430	...	...	430	392,944	
...	...	...	...	425	...	1,958	511	...	...	494	265,536	
...	...	...	...	162	...	762	298	...	...	247	136,748	
35	...	...	...	867	...	2,897	976	...	867	976	642,958	
...	...	...	...	284	...	1,158	151	...	284	151	110,204	
...	...	...	...	587	...	...	1,443	0·28	...	1,223	1,016,674	
...	...	...	...	623	...	2,935	567	...	...	817	1,426,300	
5,904	122,953	...	...	5,918	...	20,508	7,209	...	2,467	6,374	6,757,399	
...	...	...	...	...	...	...	...	...	...	...	...	
40	85	0·1	0·07	254	203	146	...	...	...	...	...	
...	...	...	...	1·4	200	...	...	...	...	...	...	
...	85	...	...	255·4	...	146	...	...	...	...	...	
...	...	...	...	158	152	...	...	...	...	...	...	
...	...	...	...	29	98	...	...	...	...	...	...	
37	...	...	...	36	83	in situ.	...	...	...	...	...	
37	...	...	...	223	...	...	...	...	...	...	...	
45				303								
...				334								
...	5,413	6	0·15	688	58	276	...	...	...	...	...	
...				2								
...				10								
50				13								
...	1,236	0.05	0·09	429	101	...	...	...	...	...	...	
...	6,649	...	...	1,779	...	276	...	...	...	...	...	

Summary of the outturn of work

Scale of Survey.	Number of Party.	Locale of field operations.		Triangulation: Instrument used. Diameter in inches.	Triangulation: Area in square miles.	Triangulation: Square miles to each point trigonometrically fixed.	Triangulation: Square miles to each height.	1st class triangulation: Stations fixed.	1st class triangulation: Triangular error in seconds.	1st class triangulation: Error per mile in feet.	Secondary: Stations fixed.	Secondary: Triangular error in seconds.	Secondary: Error per mile in feet.	Tertiary: Intersected points	Tertiary: Error per mile in feet.	Spirit-level operations: Miles levelled over.	Permanent bench-mark stones embedded.	Trigonometrical stations connected with.
Inches to a mile.		Brought forward	...	...	950	...	...	11	...	...	79	...	...	261	...	...	...	
4	18	Himálaya (District Kángra).	...	7	...	...	...	...	...	...	...	...	...	...	...	...	...	
	20	Burma Forests	...	6	1 200	63	63	...	...	...	18	10	1·3	2	...	...	...	
		Bilaspur	...	5	...	...	...	...	...	...	...	...	...	...	...	...	...	
	Forest Branch	Chhindwára	55	7	425	5·1	4·7	...	...	...	9	3	0·23	75	1·0	...	...	
		Nágpur and Wardha	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
		Chánda	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
		Seoni	...	7	...	...	...	...	...	...	...	...	...	...	...	...	...	
		Sambalpur	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
		Saugor	60	7	400	23·5	20·0	...	...	...	12	...	...	5	0·5	...	...	
		Chamba	...	7	207	2·8	2·8	...	...	...	39	10	0.7	257	1·0	...	...	
		Montgomery	...	5 & 5½	...	...	...	...	...	...	...	...	...	...	...	...	...	
		Lower Burma (Tenasserim).	...	4½ & 5½	...	...	...	...	...	...	...	...	...	...	...	...	...	
		Upper Burma (Pyinmana).	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
		Upper Burma (Ruby Mines).	65	5½ & 7	...	...	...	...	...	...	...	...	...	...	...	...	...	
		Total	...	...	3,242	...	...	11	...	...	157	...	...	600	...	...	...	
2		Jhánsi (Lalitpur Subdivision).	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
	2 & 8	Sháhjahánpur	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
		Kheri	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
	4	Champáran	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
		Sibságar	70	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
	6	Lakhimpur	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
		Nowgong	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
		Sylhet	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
	12	Sind	...	8	761	...	...	...	...	...	45	4·7	0·4	70	1·3	...	...	
	15	Gilghit, Kashmir, and Landi Khel.	75	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
	18	Himálaya	...	7	315	2·0	2·0	...	...	...	23	15·5	0·5	90	0·7	...	...	
	20	Burma Forests	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
		Total	...	...	1,076	...	...	...	...	...	68	...	...	160	...	...	...	
1	3	Lower Burma (Prome, Henzada, Thayetmyo, Sandoway, and Kyauksè).	...	6	3,512	11·8	14·6	...	...	...	30	6	0·2	265	0·5	...	...	
	10	Upper Burma (Mandalay, Kyauksè, Meiktila, Yamèthin, and S. Shan States).	...	6	2,798	6·2	7·5	...	...	...	41	8·6	0·22	430	0·7	...	...	
	11	Upper Burma (Myelat, Lawk Sawk, S. Shan States).	80	6	3,234	7·7	8	...	...	...	64	15	0·36	341	0·7	...	...	
	14	Lushai	...	7 & 6	2,473	...	...	8	7	0·23	43	14	0·29	411	1·4	...	...	
	15	Sind	...	6 & 8	2,765	18	18	...	...	...	42	6·7	0·11	132	0·6	...	...	
	21	Upper Burma, North Shan States.	...	6	3,416	11·3	15·7	...	...	...	47	8·9	0·32	344	1·1	...	...	
	Forest Branch	Chamba	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
		South Section, Boundary Commission.	85	...	4,724	...	...	...	...	...	...	...	...	...	...	...	...	
		North Section, Boundary Commission.	...	...	4,000	...	...	...	...	...	...	...	...	...	...	...	...	
		Total	...	...	26,922	...	...	8	...	...	267	...	...	1,893	...	...	...	
½	15	Gilghit, Kashmir, Dir, Chitral.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
¼	15	Sistán, Dir, Chitral,	...	6	16,000	84	...	...	...	...	191	23·1	0·52	...	...	...	...	
	21	Upper Burma (Yunnan)	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
	25	India	90	...	...	...	...	...	...	...	...	...	...	...	...	378	33	8
		South Section, Boundary Commission.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
		North Section, Boundary Commission.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
		Total	...	...	16,000	...	...	...	...	...	191	...	...	...	...	378	33	8
		GRAND TOTAL	...	...	47,676	...	...	19	...	...	887	...	...	4,267	...	378	33	8

arties during the year 1898-99—(contd.).

TRAVERSING.				DETAIL SURVEY.					RECORD-WRITING.			REMARKS.
Area in square miles.	Number of stations at which the theodolite was set up.	Angular error per station in seconds.	Linear error per *mile*.	Area in square miles.	Plane-table fixings per square mile.	Linear miles of test lines.	Villages.	Average size of fields.	Area in square miles.	Villages.	Fields.	
...	...	6,649	...	...	1,779	...	276	...	...	...	...	...	
...	...	...	...	...	156(*g*)	112	in situ.	...	...	...	...	...	(*g*) Includes 52 square miles of Forest.
186	9,078	6·8	0·07		472	225	212	...	...	...	...	...	
...	252	7	0·38		212	93	10 & in situ.	...	...	...	...	...	
...	...	...	...		253	280	112	...	...	...	...	...	
...	...	...	...		26	173	46	...	...	...	...	...	
...	...	...	...		270	254	35	...	...	...	...	...	
...	286	12	0·17		203	187	36	...	...	...	...	...	
...	...	...	...		184	241	50	...	...	...	...	...	
60	...	...	...		246	110	56	...	...	...	...	...	
...	...	...	...		100	146	in situ.	...	...	...	...	...	
...	2,085	6	0·09		...	...	...	...	...	...	...	...	
...	1,431	7	0·1		198	82	131	...	...	...	...	...	
...	...	...	...		48	273	16	...	...	...	...	...	
65	1,368	9	0·65		131	285	72	...	...	...	...	...	
...	186	21,149	...	...	4,338	...	1,052	...	...	...	...	...	
...	...	...	...	...	30	...	...	111	...	...	...	...	
...	...	...	...	...	94	...	...	46	...	...	...	...	
...	...	...	...	...	40	...	...	7	...	...	...	...	
...	95	872	...	...	95	...	...	...	...	...	...	...	
70	1,018	6,120	3·8	0·24	1,049	8	111	...	...	...	...	...	
...	35				...								
...	...	...	...	...	95								
...	23	2,141	3·7	0·21	...	...	...	...	...	...	...	...	
...	3,850	15,939	3·7	7·4	2,813	18	in situ.	...	...	...	...	...	
75	...	...	...	...	271	...	...	...	...	...	...	...	
...	...	...	...	...	622(*h*)	34·5	in situ.	...	...	...	...	...	(*h*) Includes 260 square miles of Forest.
...	...	...	...	...	87	141	9	...	...	...	...	...	
...	5,021	25,072	...	...	5,196	...	120	164	...	...	...	...	
...	291	2,936	4 & 5	...	1,963	5·2	100	...	...	...	...	...	
...	...	...	...	...	2,338(*i*)	5·2	193	...	...	...	...	...	(*i*) Includes 276 square miles overlap survey.
80	...	...	...	...	2,524(*j*)	8·5	69	...	...	...	...	...	(*j*) Includes 306 square miles of overlap survey.
...	...	...	...	...	649	2·7	...	...	...	...	...	...	
...	...	...	...	...	1,320	5	...	...	...	...	...	...	
...	...	...	...	...	1,134	...	...	...	...	...	...	...	
...	...	...	...	...	953	...	...	...	...	...	...	...	
85	...	...	...	...	915	...	...	...	...	...	...	...	
...	...	...	...	...	1,300	...	...	...	...	...	...	...	
291	2,936	...	...		13,096	...	362	...	...	...	...	...	
...	...	...	...	...	2,043	2	...	...	...	...	...	...	
...	...	...	...	...	26,274	...	...	...	...	...	...	...	
...	...	...	...	...	26,850	...	...	...	...	...	...	...	
90	...	...	...	...	...	...	...	...	...	...	...	...	
...	...	...	...	...	4,216	...	...	...	...	...	...	...	
...	...	...	...	...	7,500	...	...	...	...	...	...	...	
...	...	...	...	...	64,840	...	...	...	...	...	...	...	
11,446	174,484	...	...		95,934·4	...	22,193	7,410	...	2,471	6411	6,789,399	

Statement showing the cost-rates of work executed

Number of Party.	Nature and *locale* of field operations.	Cost-rate per square mile.										
		Triangulation.	Traversing.	Detail survey and preparation of maps on scales of								
				½″	¼″	1″	2″	4″	6″	8″	12″	16″
	Topographical Surveys.	₹	₹	₹	₹	₹	₹	₹	₹	₹	₹	₹
3	Prome, Henzada, and Thayetmyo	5·1	...	...	...	28 8	...	...	...	...	...	...
6	Lakhimpur, Sibságar, and Nowgong	...	35·1	...	...	...	8·0	...	...	...	...	
6	Sylhet and Cachar	...	31·6	...	...	...	...	...	...	...	...	
10	Upper Burma	9.8	...	...	...	20·0	...	...	...	...	...	
11	Upper Burma	11·4	...	...	...	17·5	...	...	...	...	...	
12	Sind	...	2″= 8 5 6″=49·5	...	...	...	13·1	...	90·9	...	...	...
14	Lushai	31·8(*f*) 22·2(*g*)	...	...	...	64·4	...	...	...	...	...	...
15	Sind	12″=50·7 1″= 4·5 ½″= 0·9	...	0·7	5·4	9·8	12·9	...	175·8 216·8	...	...	...
18	Himálayas	15·2	...	...	...	...	60·6	99·9	...	...	...	...
21	Upper Burma	11·6	...	1·5	...	11·8	...	...	...	...	...	...
	Forest Surveys.											
9 & 19	Coimbatore	18·6	...	...	...	...	...	51·7	...	...	...	...
9 & 19	Kurnool	15·2	...	...	...	...	...	81·5	...	...	...	...
9 & 19	Cuddapah	11·6	...	...	...	...	...	46·1	...	...	...	...
9 & 19	South Arcot	...	...	...	...	...	...	49·6	...	...	...	...
9 & 19	Madura	...	...	...	...	...	...	18·5	...	...	...	...
17	Bombay	...	...	...	...	...	...	53·2	...	136·6	...	122·9
20	Burma	14·6	132·8	...	...	...	86·4	155·4	...	131·4	...	...
Forest Branch.	Central Provinces	5·7	...	...	...	...	...	38·8	...	...	...	...
Forest Branch.	Punjab	12·2	...	...	...	7·8	...	41·3	...	...	...	...
Forest Branch.	Burma	...	...	...	...	...	...	93·8	...	...	...	...
	Cadastral Surveys.											
4	Sáran	...	36·0	...	...	...	...	...	...	...	...	72·0
4	Darbhanga	...	32·3	...	...	...	...	...	...	...	...	64·0
4	Sonthal Parganas	...	45·0	...	...	...	...	...	...	...	...	...
7	Toungoo	...	...	...	...	...	...	...	...	...	...	136·0
7	Myingyan	...	...	...	...	...	...	...	...	...	...	207·6
	Traverse Surveys.											
2 & 8	Farrukhabad	...	24·1	...	...	...	...	...	...	...	...	
2 & 8	Etáwah	...										
2 & 8	Mainpuri	...										
2 & 8	Etah	...										
2 & 8	Azamgarh	...										
2 & 8	Gonda	...										
Central Provinces Det.	Central Provinces	...	41·8	...	...	...	...	...	...	...	...	...

Field Parties during the year 1898-99.

Cost-rate per acre.	Cost-rate per square mile.			Total cost, inclusive of charges for instruments to Provincial Governments.	Remarks.
Cadastral Survey, including traversing, detail survey, and mapping.	Stone embedding.	Records (*Khanapuri*).	Completion of Vernacular records assessment statistics, etc.		
Annas.	₹	₹	₹	₹	
...	...	...	...	81,915	
...	...	...	...	61,736 (a)	(a) Includes ₹7,048 expended on completion of records; ₹1,903 on 2-inch mapping of local agency survey; ₹4,210 on field statistics; ₹2,500 on training of officers; and ₹50 on miscellaneous work for local officers.
...	...	...	...	7,514 (b)	(b) Includes ₹4,595, cost of revision survey in District Cachar; ₹350 on 2-inch mapping; and ₹2,855 on demarcation.
...	...	...	...	86,135 (c)	(c) Includes ₹11,925 expended on Maymyo Town Survey on 16-inch scale.
...	...	...	...	90,896 (d)	(d) Includes ₹9,803 expended on Burma-China Boundary Survey.
...	...	...	...	93,747 (e)	(e) Includes ₹8,814 expended on mapping.
...	...	...	...	111,668 (h)	(f) Rate of network triangulation.
					(g) Rate of 1st class secondary triangulation.
10 ...	...	...	...	114,864 (i)	(h) Includes ₹1,228 expended on the Survey of Aijal on the 24-inch scale.
					(i) Includes ₹7,415 expended on traversing.
...	...	...	...	71,700 (j)	(j) Includes ₹704 expended on Survey of Náhan Town and Cantonment; ₹14,497 for arrears of mapping, and ₹3,842 on instruction.
...	...	...	...	92,725	(k) Includes ₹1,635, cost of Survey in District Salem.
					(l) Includes ₹232 expended on Bashahr mapping.
...	...	...	...	43,926	
15 ...	...	...	...	31,299	(m) Includes ₹719 expended on diára Topographical Survey; ₹4,478 on Chapra City Survey; ₹877 on Shitab diára village Survey; ₹9,545 on 2-inch Topographical Survey of 95 square miles in District Champáran, and ₹1,687 on badars, and ₹2,028 on Bihar badars.
...	...	...	...	24,548 (k)	
...	...	...	...	496	(n) Includes ₹2,497 on arrears of work; ₹1,821 on badars; ₹5,925 on Darbhanga City Survey; ₹1,831 on revision of Khanapuri; ₹476 on Muzaffarpur work; ₹360 on Shahabad Cadastral work; ₹389 on demarcation in Kachna Mahal; ₹238 on Shahabad diára Topographical Survey; ₹1,647 on Patea diára; ₹611 on Ballia; ₹300 on Gaya arrears; ₹120 on Patna diára; ₹158 on Patna Ghát Survey; ₹1,034 on Orissa badars, and ₹575 on Roshanbad badars.
...	...	...	...	241	
...	...	...	...	69,288	
20 ...	...	...	...	123,260	
...	...	...	...	79,100	(o) Includes ₹716 on Bhágalpur-Nepál Boundary Survey; ₹28 on Bindadiara Village Survey; and ₹6,506 on Khurda badars.
...	...	...	...	16,726 (l)	
...	...	...	...	42,311	(p) Includes ₹9,946, cost of Revision Survey of 46 square miles = 90 villages = 52,956 fields, giving a rate of ₹216·2 per square mile.
... 2·70	...	59·0	...	101,248 (m)	(q) Includes ₹58,215 expended on arrears of work in Districts Shwebo, etc.
25 2·41	1·7	84·0	...	140,870 (n)	(r) Includes ₹1,055 debitable to North-Western Provinces Government for work done in Bulandshahr, etc., ₹6,322, cost of 2-inch detail survey of 164 square miles in District Jhánsi, Sháhjahánpur and Kheri giving a rate of ₹38·5 per square mile; and ₹13,147 cost of North-Western Provinces Drawing Office.
... ...	...	...	...	39,963 (o)	
... 3·40	...	...	...	100,352 (p)	
... 5·19	...	...	...	80,743 (q)	
... ...	2·2	...	...	120,557 (r)	
35 ...	1·2	...	...	20,543	

Particulars of Cadastral Surveys completed since 1897-98.

District.	Scale of survey.	Number of villages.	Number of fields.	Area surveyed in square miles.	Average size of fields in acres.	Cost, exclusive of demarcation and charge for instruments.	Rate per square mile.			By whom and when surveyed.
							Traverse survey.	Cadastral survey.	Cadastral survey with record-of-rights.	
						R	*R a. p.*		*R a. p.*	
Bareilly	16″ = 1 mile	2,109	1,622,490	1,580	0·62	1,59,331	27 1 2	...	73 12 4	Traverse survey done by Mr. J. S. Pemberton during 1895—97. Cadastral survey done by Land Records Surveys.
Kheri	„	1,752	1,940,020	2,551	0·84	2,16,461	31 6 0	...	53 7 6	Traverse survey done by Captain J. M. Fleming and Mr. J. S. Pemberton during 1895—98. Cadastral survey done by Land Records Surveys.

PART III.

THE OPERATIONS AT THE HEAD-QUARTERS OFFICES.

339. These offices comprise—

(1) The Head-Quarters Offices at Calcutta.
(2) The Trigonometrical Branch Office at Dehra Dún.
(3) The North-Western Frontier Drawing Office.
(4) The Forest Survey Branch Office at Dehra Dún.

A description of the work carried on in each office is given below:—

I.—HEAD-QUARTERS OFFICES, CALCUTTA.

SUPERINTENDENCE, CORRESPONDENCE, AND ACCOUNTS.

Superintendence.

Major-General C. Strahan, R.E., Surveyor-General of India.
Lieutenant-Colonel J. R. Hobday, I.S.C., Deputy Surveyor-General, in charge Revenue Branch.
Major S. G. Burrard, R.E., Assistant Surveyor-General, from 31st October 1898 to 4th February 1899.
Captain P. J. Gordon, I.S.C., Officiating Assistant Surveyor-General, from 23rd May 1899 to the close of the year.
Captain H. A. D. Fraser, R.E., Officiating Assistant Surveyor-General, from 1st to 13th October 1898.
Lieutenant G. A. Beazeley, R.E., Officiating Assistant Surveyor-General, from 14th to 30th October 1898 and again from 5th February to 22nd May 1899.
Mr. T. W. Babonau, Registrar, on leave, from 24th July 1899.
„ T. A. Milne, Officiating Registrar, from 24th July 1899.

Correspondence.

Mr. T. A. Milne, Head Assistant.
„ G. C. Walker, Head Clerk.
Babu Kalipodo Banerji, Clerk.
„ Beni Madhab Banerji, „
„ Chuni Lal Dey, „
„ Durga Narain Ghosh, „
„ Ram Kristo Chunder, „
Mr. H. E. D'Cruz, on leave.
Babu Gopal Chunder Dass, Clerk.
Babu Kali Kristo Chunder „
and seven others.

Accounts.

Mr. C. O. Gray, Head Clerk.
Babu Raj Krishna Mukerji, Clerk.
Babu Hem Nath Dutt „
and nine others.

340. The general direction of these offices remained in the hands of Major-General C. Strahan, R.E., throughout the year, and the Revenue Branch Section under Lieutenant-Colonel J. R. Hobday, I.S.C. The General and Topographical Branch Sections were under Captain H. A. D. Fraser, R.E., up to 13th October 1898, under Lieutenant G. A. Beazeley, R.E., from 14th to 30th October, and again from 5th February up to 22nd May 1899; under Major S. G. Burrard, R.E., from 31st October up to 4th February 1899, and under Captain P. J. Gordon, I.S.C., from 23rd May up to the close of the year.*

* The Assistant Surveyor-General reports as follows:—

The work of this office has been carried on satisfactorily under the respective heads of sections, amongst whom Mr. Gray is deserving of special mention for the willing way in which he has devoted himself to his work, both in and out of office hours.

DRAWING OFFICE.

341. The Drawing Office continued under the superintendence of Mr. A. E. Spring throughout the year.

SECTION I.—GEOGRAPHICAL, DRAWING, AND COMPILATION.

342. During the year, a few changes took place in the *personnel* of this section. Mr. A. J. Wilson, a young and promising draftsman, died of malarious fever on the 2nd November 1898. Mr. W. Green retired on pension on the 9th September 1899, after a service of 37 years. He was a first class draftsman, and had for years been employed on drawing the sheets of the Atlas of India; he excelled in the art of hill shading by brushwork, and his loss will be very much felt in this section. Messrs. J. Kitchen and E. B. West were appointed to the two last posts of draftsmen, which fell vacant by the death of Mr. Wilson and the retirement of Mr. W. Green.

Personnel.

Mr. W. Stotesbury, Chief Draftsman.

Extra Assistant Superintendents and Sub-Assistant Superintendents on duty and European draftsmen.

Mr. A. G. Wyatt, Extra Assistant Superintendent, 2nd grade.
Mr. T. H. Rendell, Extra Assistant Superintendent, 3rd grade.
Mr. J. A. Barker, Extra Assistant Superintendent, 4th grade, up to 5th October 1898.
Mr. R. C. D. Ewing, Extra Assistant Superintendent, 4th grade, from 4th March.
Mr. G. Campbell, Extra Assistant Superintendent, 5th grade.
Mr. J. Murphy, Extra Assistant Superintendent, 5th grade, from 1st June.
Mr. P. F. Prunty, Extra Assistant Superintendent, 5th grade, up to 12th June.
Mr. S. O. Madras, Sub-Assistant Superintendent, 1st grade, up to 22nd April.
Mr. P. K. Vaughan, Sub-Assistant Superintendent, 2nd grade, up to 26th May.
Mr. A. H. Peychers, Sub-Assistant Superintendent, 2nd grade, up to 31st October.
Mr. C. C. Byrne, Sub-Assistant Superintendent, 3rd grade, up to 11th November.
Mr. W. Green, Draftsman, up to 26th September.
Mr. A. J. Musgrove, Draftsman.
Mr. A. S. Bateman, Draftsman.
Mr. A. J. Wilson, Draftsman, up to 3rd November.
Mr. C. L. Green, Draftsman.
„ E. W. Stark, „
„ A. S. Nelson, „
„ J. Kitchen, „ from 4th November 1898.
Mr. E. B. West, Draftsman, from 27th September 1899.

Native Draftsmen.

Babu Purna Chandar Sen.
„ Sarat Chandar Chatarji.
„ Narendra Nath Mukarji.
„ Subodh Chandar Sarkar.
„ Sarat Chandar Kumar and 28 others.

343. The compilation, correction, and bringing up to date of the maps of the several frontier series was still carried on by this section, but during the year it was relieved of all work appertaining to the N.-W. Frontier, this work having been transferred to the N.-W. Frontier Drawing Office. The following sheets of the North-Eastern Frontier Series were taken in hand, brought up to date and published: 15 S. E. (6th edition), 22 S.-W. (2nd edition); all on the 4-mile scale, and sheets 22 (6th edition) and 23 (2nd edition), on the 8-mile scale, were also similarly treated, the first being published and the latter is having the hill drawing now completed. Of the South-Eastern Frontier Series sheets, 2 S.-E. (5th edition), 2 S.-W. (2nd edition), 4 N.-W. (6th edition), 5 S.-W. (6th edition), 6 N.-W. (7th edition) were also added to and published; and sheets 1 N.-E. (7th edition), 1 S.-E. (5th edition), 1 N.-W. (5th edition), 1 S.-W. (4th edition), 2 N.-E. (7th edition) were also taken in hand and are now ready for publication; all these sheets are on the 4-mile scale, those on the 8-mile which also had additions or corrections made thereto were, sheet 4 (2nd edition), sheets 5 and 6 (2nd edition), 7 (2nd edition), and 8 (2nd edition).

344. The standard sheets on the 1-inch scale, which were corrected and brought up to date as regards boundaries, railways, roads, etc., were of Assam, 4 sheets; Bengal, 6 sheets; Central India and Rájputána, 16 sheets; Central Provinces, 10 sheets; Hyderabad, 1 sheet; N.-W. Provinces 1 sheet; Upper Burma, sheets Nos. 305, 307, 315, 351, 352, 353, 358, 360, 361, 362, 306 (2nd edition), 304, 350, 398 399, 402, and 458 were published during the year, and sheets Nos. 260 (2nd edition), 316, 400, 401, 403, 404, 405, 406, and 407 are now passing through the proof stage and will be published early next year. Sheets 313 and 314 had their boundaries corrected and brought up to date. Standard sheets on other scales which were examined and passed through to press, were 4 sheets, on the ½-inch scale of Assam; 4 sheets of Central India and Rájputána, on ½-inch scale; Punjab, 16 sheets on 2-inch scale, were completed and published and 6 sheets on the 2-inch scale are now under publication. Sheets on the 4-inch scale which were dealt with, added to and published, were Central Provinces,

1 sheet; Bombay, 1 sheet; Madras Forests, 54 sheets; N.-W. Provinces, 4 sheets, and Burma Forests, 26 sheets.

345. The sheets of the Atlas of India formed as usual a large part of the work of this section, as many as 123 of them had additions of railways, roads, canals or corrections to boundaries made to them, 14 of them having been brush-shaded and sent for engraving.

346. The General maps which were dealt with during the year are the 32-mile map of India (3rd edition) published; Afghánistán, 24-mile scale; Route map of the Western Himálayas, Kashmir, Punjab, and Northern India on the 32-mile scale, was brought up to date; Railway map of India on 32-mile scale, Railway map of India on 48-mile scale, India on 80-mile scale, India on 96-mile scale, and India on 128-mile scale were brought up to date and published. The Railway map of India on 32-mile scale, showing railway and steamer stations, mentioned in last year's report as having been put in hand, was completed and would have been published, but for the numerous additions made to it since it was in proof; these are now in hand and the map will be published early next year, the new Military and Canal maps of India on 32-mile scale are still under preparation.

Of the Provincial maps of India, mostly on the 16-mile scale, 41 were added to, corrected, and brought up to date, and those of the Bombay Presidency, Madras Presidency, and Punjab had the hills brush-shaded and sent for engraving. Of the Divisional maps 7 were brought up to date and 29 District maps on $\frac{1}{4}$-inch and $\frac{1}{8}$-inch scales were similarly dealt with, and 42 Administrative Report maps, mostly on $\frac{1}{8}$-inch scale, were corrected to date, that of Kohát had the hills brush-shaded and sent for engraving.

Of the cantonment and city plans, 12 of them had corrections and additions made to them. The revision of the sheets of the Town of Calcutta, on the scale of 1 inch = 50 feet, was sanctioned by the Bengal Government, and during the year 18 sheets were revised and the new work tested by a Provincial Officer, 9 sheets were sent to press to have the zinc plates corrected and 2 sheets were published as 2nd editions. Of the index maps required to illustrate this report, 12 were prepared and 15 others were brought up to date. Besides this, 14 triangulation charts were examined and passed, 5 of them being published. As usual a large number of maps were prepared for other departments, 46 sheets were taken in hand, of these 6 being required by the Military Department for manœuvres; the postal map of Bengal being drawn on 4-mile scale for reduction to 8-mile scale, the postal map of Bihar also on the same scale: the Military Route map on 8-mile scale is also well advanced; 9 maps to illustrate Mr. G. A. Grierson's Linguistic Survey and one map for Mr. Forest's work on the Indian Mutiny.

347. The colouring of 1,986 maps as office copies and for other Departments was also accomplished. A large amount of professional data was extracted and supplied to various officers. During the year, all the clerical work in connection with the correspondence of this section, such as docketing, registering, recording, and copying was transferred from the correspondence section, Surveyor-General's Office, to this section, and this has been a very heavy job as 3,176 letters were received, replied to, and recorded during the past year.

SECTION II.—REVENUE.

348. The work of this section consists in examining and preparing for photo-zincography, the fair maps received from the field parties of the Revenue Branch; in bringing up to date and republishing the old maps; in the preparation of the index maps for field parties, and for the General Report; in colouring maps on various scales, in tracing maps, furnishing plans and supplying data to Government officials and others. The examination of the field books, and azimuth computations, etc., on which the several Revenue Surveys are based, is also done in this section.

Personnel.

Mr. E P. S. Hill, Head Draftsman.

Extra Assistant and Sub-Assistant Superintendents on duty.

Mr. J. Murphy, Extra Assistant Superintendent, 5th grade, from 14th September 1899.
Mr. P. F. Prunty, Extra Assistant Superintendent, 6th grade, up to 3rd April 1899.
Mr. S. O. Madras, Sub-Assistant Superintendent, 1st grade, from 24th April 1899.
Mr. P. K. Vaughan, Sub-Assistant Superintendent, 2nd grade.

Native Draftsmen.

Munshi Abdul Aziz.
„ Abdur Razak.
Babu Tincowri Sen.
„ Bacharam Banarji.
„ Ram Chandar Sen.
„ Harendra Krishna Gupta and 19 others

Sub-Surveyors, etc., on duty.

Babu Rhidoy Chandar Das.

349. Of the maps of district Pesháwar (Punjab) reported on last year, in paragraph 373, the drawing of five sheets on scale 1-inch = 1 mile for reproduction to full scale was finished; two of them are

passing through press, the remaining three will be sent to press shortly. The compilation of sheets Nos. 108 and 134 which complete the district is in progress.

The maps of district Dera Gházi Khan (Punjab), in twenty sheets, were corrected from tracings supplied by the Settlement Officer. Similar corrections were carried out in the districts of Bhandára, Betúl, and Nimár (Central Provinces) from 16-inch tracings supplied by the Settlement Department.

350. Eighteen large scale plans of cities and cantonments on various scales were corrected, and additions made thereto, from information supplied by the Executive Engineer and Military authorities. The Bareilly Cantonment plan on the 12-inch scale is in 21 sheets and that of Murree on the 10-inch scale contains 6 sheets. The 19 sheets of the map of Moulmein Town on the scale of 1 inch=50 feet, referred to in paragraph 379 of last year's report, were published during the year under report. Of the Rangoon Town maps, 191 sheets on the scale of 1 inch=50 feet, were published during the year, and 154 originals on the scale of 1 inch=100 feet were sent to press for re-production.

351. Standard Sheets Nos. 15 and 221 of the North-Western Provinces and Oudh were published during the year; 28 sheets of districts Meerut, Moradabad, Saháranpur, Muzaffarnagar, Aligarh, Agra, Muttra, Gházipur, Benares, Mirzápur, Basti and Gorakhpur were sent to press. The compilation of standard sheet No. 27 containing the parts of the districts of Saháranpur, Garhwál, Dehra Dún, and Bijnor is in progress. Of the Standard Sheets of Bengal 8 are in press after being corrected up to date, and sheet No. 389 has been compiled from the old main circuit maps. For the Bombay Presidency 4 standard sheets have been published during the year and 9 are in press, 6 standard maps of Lower Burma and 5 of Upper Burma are in press. In addition to the above 36 *Pargana* maps (Bengal) of districts Birbhum, Champáran, Cuttack, Dacca, Monghyr, Mymensingh, Nadia, Cooch Behar, Rájsháhi, and Tippera had corrections to roads, boundaries, etc., carried out.

352. A large amount of mapping has, as usual, been done for other departments. The special map of Narhan Estate referred to in paragraph 381 of last year's Report was published. A map of the Civil Station of Basti (N.-W. P. & Oudh) on the scale of 8 inches=1 mile for the Commissioner, Gorakhpur division, was compiled and published. A military map of Calcutta and 10 miles of surrounding country on the scale of 1 inch=1 mile was compiled and published for the Commanding Officer at Fort William. A similar map in 2 sections on the 2 inches=1 mile scale for the same officer is in press. The map of Calcutta city with suburbs (in 2 sections) on scale 6 inches=1 mile, referred to in paragraph 379 of last year's Report, is passing through press.

353. A large number of original fair sheets together with computation volumes received from field parties were cursorily examined and reported on. The traverse computations of districts Magwe (Burma) and Sylhet (Assam) extending over three seasons each were thoroughly examined during the year. Traverse data, calculation of areas, and such like information has, as usual, been prepared in this office and supplied to field parties and district officials. Of traverse data 2,324 pages were copied and supplied. The spherical values of certain pillars along the Nepál boundary were computed. The area was calculated by *tálukas* of the Nizam's Dominions and sheet No. 201 Bombay. The *pargana* areas of sheets 307 and 347 of the Central India Agency were computed. The district areas of 24-Parganas and Ránchi (Bengal), and Gurdáspur, Jhelum and Ráwalpindi (Punjab), the Sámbhar Lake in Rájputána, and of the Bunaili Raj estates in sheets Nos. 1, 3, 4, 8, 9, 10, 11, and 17, district Bhágalpur, were also computed. The revised areas of districts Cuttack, Puri, and Balasore were supplied to the Settlement Officer. The computation and plotting of 4 traverse circuits and 11 sub-circuits in connection with the map of Calcutta and 10 miles of surrounding country on the scale of 2 inches=1 mile was prepared. The traverses for a group of 13 villages were plotted for the Collector of Pabna. The traverse stations of one line of villages transferred from district Midnapore to district Hooghly were plotted. A statement detailing the areas by Imperial Traverse Surveys, Cadastral Surveys by local Agency, and by Forest Surveys in the Central Provinces was prepared.

Eighty-two tracings of sheets and twenty-one tracings of village plans were also made and supplied to district and other officers. Forty-six maps on various scales were coloured for office use. Twenty-two thousand four hundred

and sixty-five maps coloured in Map Record and Issue Office for stock were examined in this section.

Since April 1899 the entire correspondence has been carried on in this section. The total number of letters dealt with being 1,269.

Applications for manuscript copies of maps were also dealt with in this section. During the year 716 applications were received and disposed of. The correspondence in connection with this portion of the office reached 988 letters. Rupees 1,076-5-0 was received and deposited in the accounts section as Government Fees.

SECTION III.—CADASTRAL.

354. This section is employed in preparing the original maps of all cadastral surveys for photo-zincography and zincography. The maps to be examined are, on receipt of the originals, submitted to a cursory examination in order to see that the sheets are in every respect fit for reproduction.

Personnel.

Mr. W. H. D. Ewing, Sub-Assistant Superintendent, 1st grade.

Permanent Establishment.

6 Draftsmen. 1 Writer.

Temporary Establishment.

6 Tracers. 3 Moharrirs.

355. In the North-Western Provinces the returns for the previous year showed 633 sheets of district Garhwál remaining to be published, and during the year these have been published.

In Burma the returns for the previous year showed 1,908 sheets remaining to be published, and during the past 12 months 4,217 sheets of district Katha, Magwe, Meiktila, Meiktila Town, Sagaing, and Shwebo of Upper Burma and Pegu of Lower Burma were received from Parties; out of these 3,431 sheets of the same have been published, leaving a balance of 2,694 sheets remaining to be printed; of these 700 sheets have been prepared for publication; 5 sheets of district Thatôn have been reprinted.

In Bengal 289 sheets of district Gaya, Tikari Ward's Estate, have been published by the sanction of the Board of Revenue, Lower Provinces; the remaining 411 sheets will be printed during the coming season; of these 50 sheets have already been prepared for publication.

In Assam the returns for the previous year showed 64 sheets remaining to be published, and during the past 12 months 685 original sheets of district Cachar were received; out of these 256 sheets have been published during the year, leaving a balance of 493 sheets remaining to be printed; of these 100 sheets have been prepared for publication; 23 shets of district Darrang and 1 sheet of district Lakhimpur have been re-published and 1 sheet of Index to the villages of district Jaintia, Sylhet, has been published. Those remaining incomplete, are districts Kámrúp (8 sheets), Sibságar (8 sheets), and Sylhet (45 sheets): these are mostly blocks and waste lands and under existing orders are not to be printed.

356. The total number of maps passed for publication during the year was 4,626, of which 4,609 were actualy printed, 3,528 having been photo-zincographed and 1,081 zincographed. At the close of the year there were remaining to be published 3,659 sheets against 2,666 sheets in last year, showing an increase of 993 sheets.

357. The services of 3 *moharrirs* were engaged during the 12 months under report in *badar* corrections of district Tippera, 468 original sheets have been corrected in the Central and Southern divisions of districts Tippera and Noákháli, and 106 original sheets of the *char* lands of district Noákháli. In addition to the above Field Area Statements have been corrected, and a good deal of miscellaneous work for Collectors, Settlement Officers, and others has been done.

SECTION IV.—BENGAL PROVINCIAL.

358. The cadastral maps dealt with during the year were those of Bihar, Orissa, and Chittagong.

Personnel.

Mr. A. B. Smart, Sub-Assistant Superintendent, 1st grade.

Permanent Establishment.

6 Draftsmen.

Temporary Establishment.

6 Computers, Writers, etc.
5 Draftsmen.

For Bihar, 1,062 cadastral maps, which were received during previous years, were reduced by pantagraph to the scale of 2 inches=1 mile for the completion of the Standard sheets. There were received during the year 4,778 maps, of which 1,895

were reduced by pantagraph, leaving a balance of 2,883 to be dealt with during the current year.

359. The reduction of 2,144 cadastral maps of Chittagong, received during previous years, to the scale of 2 inches = 1 mile, was completed during the year under report.

360. The publication of the Orissa standard maps has been considerably delayed, owing to numerous unsettled boundary disputes and the non-return of the proof sheets from the Settlement authorities. The outlining of 6 sheets was completed during the year under report.

For Bihar, 24 sheets were outlined and completed. The interior details of 32 sheets were finally examined and forwarded to the Photographic Office for reduction to the scale of 1 inch = 1 mile. The outlining and completing of 32 sheets has yet to be dealt with.

The publication of 60 sheets of Chittagong was taken in hand during the year under report, all of which have been projected and plotted and the outlining of 16 sheets completed.

Of the special publication of 26 Standard sheets of Orissa on the scale of 2 inches = 1 mile, called for by the Government of Bengal, 9 sheets were published during the year under report.*

ENGRAVING OFFICE.

361. Mr. A. E. Spring held charge of this Office throughout the year. Mr. Fulford, the Head Engraver, who was on an extension of service, died on the 24th November 1898, having held the appointment for seven and a half years. Mr. Fulford was a most capable officer, and he took a share in starting the art of engraving in this country; his death is much to be regretted as he would have retired in a few months, he having completed 26 years' service. Mr. S. M. Coard has succeeded him as Head Engraver, and Mr. A. R. Coard appointed Assistant Head Engraver under the scheme of 1895.

Personnel.

Mr. A. E. Spring, Assistant Surveyor-General, in charge.
Mr. J. Fulford, Head Engraver, died 24th November 1898.
Mr. S. M. Coard, Head Engraver, from 25th November 1898.
Mr. A. R. Coard, Assistant Head Engraver, from 25th November 1898.
Mr. A. W. N. James, Engraver.
" E. Earle, "
" F. R. C. Scallan, "
" E. C. V. Ollenbach, "
" L. H. Musgrove, "
" A. T. Vieux, "
" A. E. W. Cann, "
" H. H. Green, "
" R. Rodger, "
30 Native Engravers
1 Apprentice

Copper-plate Printing Section.

Mr. W. T. Collins, Copper-plate Printer.
" A. E. Pilley, Assistant Copper-plate Printer and Store-keeper.
4 Native Copper-plate Printers and 12 pressmen.

362. The outturn of work for the year has been most satisfactory, the outline and writing both being in excess of last year, the hills only being slightly less.

363. During the year, eight quarter atlas sheets have been completed and published, 13 district maps for administration reports, 3 plates for the longitude volume, three tint plates, and one plate of scales have been completed.

364. Sixty-three unpublished quarter sheets in various stages of progress have had new material added to them; 50 published quarter sheets and 15 full sheets have been in hand for corrections and additions, bringing them up to date for printing and 29 new plates have been projected or had the borders engraved. In all 306 sheets have been in hand.

365. A new map of India on the 64-mile scale in four sheets has been projected and dry prints supplied to the Drawing Office for the latest material. It is intended that this map should replace the one now available, as it is becoming much worn and is beyond being brought up to date in recent surveys and

* Mr. Stotesbury and Mr. Hill, in their posts as Chief and Head Draftsmen, respectively, supervised their establishments very efficiently. Messrs. Wyatt, Smart, and Ewing have also done well as heads of the Examining, Bengal Drawing, and Cadastral Sections. Mr. Madras has also done good work. The European draftsmen have been well reported on, especially, Mr. Musgrove. Of the Native Establishment Babus Purna Chandar Sen, Sarat Chandar Chatarji, Narendra Nath Mukarji, Subodh Chandar Sarkar, Bepin Behari Ghose are especially commended and Munshi Abdul Aziz, Abdur Razaq, Babus Tincowri Sen, Bacharam Banarji, Ram Chandar Sen, Harendra Krishna Gupta, and Rash Behari Sen, amongst others, have rendered good service.

spelling, the four sheets of this map are in hand, being brought up to date in railways only. The hill-etching on the 128-mile map of India has made good progress. India 80-mile and 96-mile maps have had all the additional railways cut, to bring them up to date, and the 256-mile map has been put in hand for hills.

366. Of the 16-mile provincial maps, Bengal in 2 sheets, has had two portions of new material added, the outline of which is completed and the writing well advanced, the map of the Bombay Presidency has had some new material added. Central India, Central Provinces, Gujarát, Madras, and Rájputána have all been in hand for corrections and additions. The four sheets of Punjab and Kashmir without hills have been in hand and heavy additions are being carried out on sheets 1 and 3, the hills have been completed on the four hill sheets, but as the new material now being engraved on the duplicate sheets will have to be cut on the hill sheets, the publication of this map on copper must be held over; the map of the Punjab on the 32-mile scale is in progress with heavy corrections. Fifteen district maps for administration reports (besides those mentioned as published), 6 Index maps, 5 charts, 4 imprint, and note plates have been added to. Fifty-three plates have had titles and foot-notes cut on them for the Photo-Litho. Office.

367. The process of cutting out the corrections from the face of the plate, and filling the holes by electro-deposited copper, has been carried out on 12 plates, and has apparently been most successful; it is hoped by this process not only to save the copper-plate from being beaten out of shape, but that the plates will be brought up to date more effectively than by the process of beating out the corrections, as only a limited number could be carried out by the old process.

368. The Copper-plate Printing Section pulled 18,624 impressions: although this number is less than last year, the impressions were taken from larger plates, and thus more time was occupied in pulling them: the section was kept hard at work the whole year and is unable to cope with the demand for copies of engraved maps which is becoming very great. The Steel-facing Section has dealt with 236 plates.*

* The Head Engraver, Mr. S. M. Coard, has given great satisfaction in the discharge of his duties. Both the European and Native Engravers, and the Copper-plate Printer have given entire satisfaction.

THE PHOTOGRAPHIC AND LITHOGRAPHIC OFFICE.

369. The charge of this Office was held by Mr. T. A. Pope throughout the year, except for three months from the middle of June, when he proceeded on privilege leave to England, during which period the charge was held by Major J. M. Fleming, S. C.

Sergeant F. R. Vandyke, R.E., Foreman Litho. Printer, proceeded on furlough to England for one year in February 1899, and during his absence Mr. D. Deas, Assistant, 2nd Division, officiated for him.

370. An abstract of the work performed during the year in each section of the Office is given in the following statement:—

Personnel.

Mr. T. A. Pope, Assistant Surveyor-General, in charge, up to 17th June 1899 and from 15th September 1899.

Major J. M. Fleming, S.C., Officiating Assistant Surveyor-General, in charge, from 18th June to 14th September 1899.

FIRST DIVISION.

Mr R. Fogarty, Head Assistant, Litho. Branch.
Mr. H. Haward, Head Assistant, Photo. Branch.
Mr. A. W. Turner, Photo-Engraver.
Sergeant F. R. Vandyke, R.E., Foreman Litho. Printer, up to 9th February 1899.

SECOND DIVISION.

Mr. E. A. LeFranc, Assistant.
„ R. George, „
„ D. Deas, „
„ L. Lagnier, „
„ T. Lloyd, „
„ J. B. MacKenzie, „
„ E. DePyvah, „
„ C. J. Meade, „
„ S. U. Ravenscroft, „
„ P. Michael, „
„ A. J. J. Rodrigues, „
Babu Ambika Churn Mukerjee, „
Mr. C. Andrews, „
„ F. N. Murphy, „
Munshi Abdul Mujeed, „
Mr. N. J. Gonsalves, „
„ J. Vieux, „
and 4 apprentices.

THIRD DIVISION.

Munshi Mohamed Yasin, Sub-Assistant.
Munshi Abdul Hakim, Sub-Assistant.
Munshi Abdul Rahman, Sub-Assistant.
Munshi Hyder Ali, Sub-Assistant.
Babu Dino Nath Dass, Sub-Assistant
Munshi Azeezoor Rahman, Sub-Assistant.
Babu Srenibas Pattra, Sub-Assistant,
Babu Bhootnath Nath, Sub-Assistant.
Munshi Enayetullah, Sub-Assistant.
Babu Ambica Churn Bhattacharji, Sub-Assistant.
Babu Gossain Dass Nath, Sub-Assistant, and 45 Sub-Assistants.

FOURTH DIVISION.

49 Press-Assistants.

Correspondence, Stores, and Accounts Section.

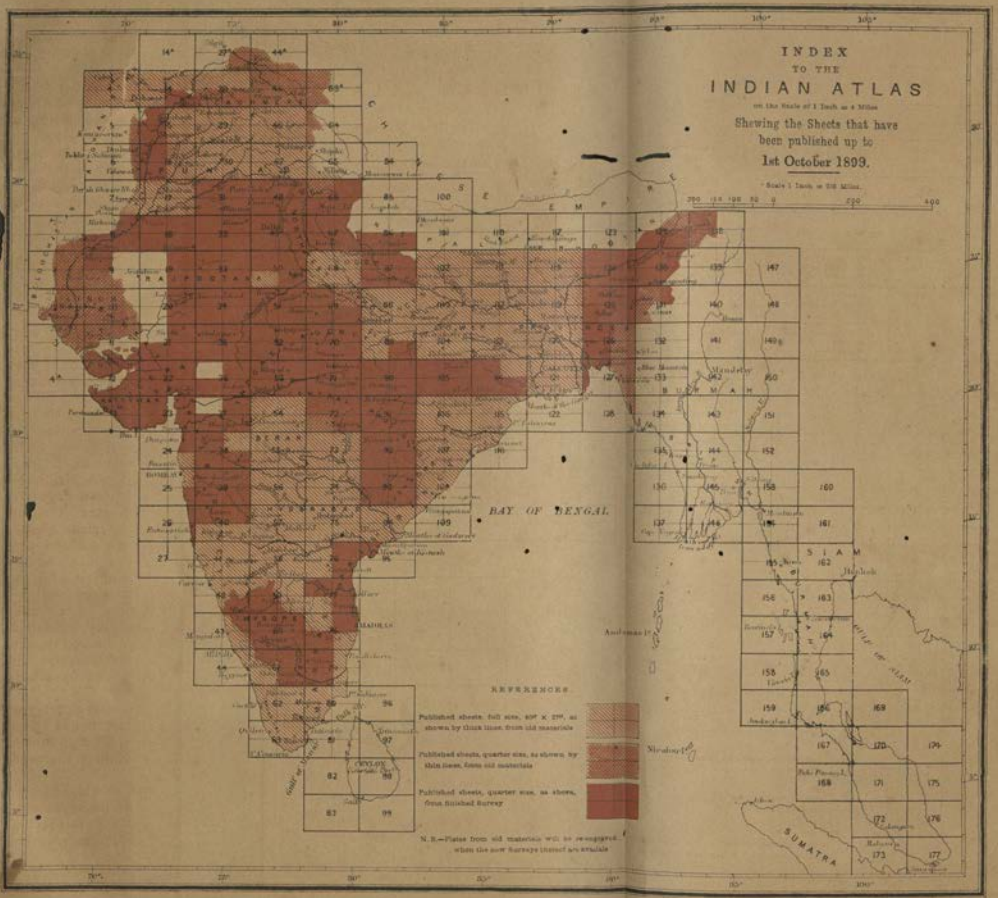
Babu Kanny Lall Sen, Storekeeper.
Mr. A. B Carville, Head Clerk.
Babu Khetter Mohan Dass, Clerk.
Babu Gopal Chundra Mukerji, Clerk.
Babu Surja Kumar Banerji, Clerk.
„ Rajani Kanta Chatterji, „
„ Ganoda Prosad Pal, „
and 6 clerks.

INFERIOR ESTABLISHMENT.

1 Fireman.
9 Machine men.
150 Spongemen, grainers, pressmen, etc.

General Abstract of Work done during the year 1898-99.

CLASSIFICATION.	Sheets or subjects.	Negatives and transparencies.	PHOTO-ZINCOGRAPHIC AND LITHOGRAPHIC PRINTING.								TYPE PRINTING.			SILVER AND OTHER PRINTING.		HELIOGRAVURE AND ELECTROTYPING.				VALUE.
			Photo-transfer Prints.	Zinc Plates transferred.	Zinc Plates printed.	Stones.	Pulls.	Number of copies. Coloured.	Uncoloured.	Total.	Pages or items.	Pulls.	Copies.	Silver Prints.	Blue Prints.	Heliogravure Plates.	Heliogravure Prints.	Photo. Blocks.	Electrotypes.	
																				R a. p.
Departmental Maps,	654	816	913	316	301	58	165,485	14,565	120,529	135,094	13,932	1,277,949	684,039	47	1,416	17	4,292	1	8	58,350 4 9
Cadastral Maps	4,695	3,621	3,645	4,621	4,621	...	145,312	...	136,630	136,630	...	...	...	...	...	...	...	...	...	64,487 15 0
Extra-Departmental Maps, etc.	1,524	1,100	1,153	568	626	420	671,423	123,616	570,113	693,729	...	...	...	73	215	111	82,222	77	...	94,813 14 9
Total	6,873	5,567	5,711	5,505	5,548	478	982,220	138,181	827,272	965,453	13,932	1,277,949	684,039	120	1,631	128	86,514	78	8	2,17,622 2 6
TOTALS OF 1897-98	6,364	5,242	5,161	5,387	5,566	523	815,562	124,811	570,971	695,812	13,819	1,176,837	700,756	283	2,174	101	73,801	82	13	1,92,927 2 0
Differences	+ 509	+ 325	+ 550	+ 118	− 8	− 46	+ 166,658	+ 13,340	+ 256,301	+ 269,641	+ 113	− 101,112	− 16,717	− 163	− 543	+ 27	+ 12,713	− 4	− 5	+ 24,694 10 6


INDEX
TO THE
INDIAN ATLAS
on the Scale of 1 Inch to 4 Miles
Shewing the Sheets that have been published up to
1st October 1899.
Scale 1 Inch = 256 Miles.
BAY OF BENGAL
REFERENCES
Published sheets, full size, 30' x 27', as shown by thick lines, from old materials
Published sheets, quarter size, as shown by thin lines, from old materials
Published sheets, quarter size, as above, from finished Survey
N. B.—Plates from old materials will be re-engraved when the new Surveys thereof are available
SIAM
SUMATRA

No. 408-S 94

Capt. H. A. D. Fraser R.E. Photo

Photogravure Survey of India Offices, Calcutta, December 1899.

THYOLICHING TRIGONOMETRICAL STATION

A PRINCIPAL STATION OF THE MANIPUR LONGITUDINAL SERIES

Height above sea level 6500 feet

The statement shows that there has been a large increase in the outturn of work of all kinds during the year under report, and that this increase is chiefly under the head of work done for other departments. The number of original subjects received for reproduction was 6,875, or 509 in excess of the number received last year. The printed outturn of maps, plans, etc., yielded by the machines and presses amounted to the large total of 965,453 copies, or 269,451 more than the outturn of last year. The departmental work done is somewhat less in quantity, except as regards copies of cadastral maps, of which the number rose from 94,328 copies printed last year to 136,630. This is due to the fact that the cadastral sheets dealt with principally comprised those of Burma and Assam, of which a much larger number is required than of the North-Western Provinces sheets, which formed the bulk of last year's cadastral outturn. The work done for other departments shows an enormous increase, and if it continues to increase, it will be a difficult problem to know how to deal with it in the future. Of the total outturn of 965,453 copies printed, 693,729 were copies of maps, plans, etc., received from other departments, or nearly three-fourths. The proportion of work done in colours remains about the same, but the number of copies printed of each subject still averages smaller than was formerly the case, where extra-departmental work is concerned. The outturn of type-printing, which depends principally upon the demands of the Survey Department for professional and other forms, is about the same as last year, though the work actually done as represented by the number of pages set up and of pulls made, is larger. The Heliogravure Section also shows a satisfactory increase of work, both in photogravure and half-tone block work. The number of prints from photo-etched plates rose from 71,280 last year to 86,514 during the year under report, which is about as large an outturn as can be obtained from the printing power available. The total value of the work in all sections was R2,17,622, or R24,695 more than last year.

371. Of the departmental publications of the year, the following may be specially referred to:—

The third edition of the map of India, on the 32-mile scale, in six sheets, which had been held over for some years on account of frontier boundaries, was finally published in December 1898. As mentioned in paragraph 402 of last year's report, a considerable amount of work had to be done after the receipt of final press order before the map could be printed. Re-transfers had to be made from each of the six stones to zinc plates, and some of these required a great deal of touching up owing to the large number of corrections which had previously been made on the stones. Three hundred copies were printed off. Two skeleton maps of India, on the 32 and 48-mile scales, in six sheets and two sheets, respectively, were also published during the year. A map of Upper Burma, on the 64-mile scale, was photo-zincographed, and also a railway map of India on the 48-mile scale, corrected up to 31st March 1899. A new railway map of India shewing stations, on the 32-mile scale, in six sheets, was photo-zincographed but not printed off.

Of provincial maps, the map of Burma and adjacent countries, on the 32-mile scale, with hills in brown, was photo-zincographed, and 200 copies were printed off. Maps of the Bombay and Madras Presidencies, and of the Nizam's Dominions, including the Assigned Districts of Berar, were lithographed, and 200 copies of each printed.

The following district maps were printed off:—Monghyr (sheet No. 8) and 24-Parganas (sheets Nos. 3, 4, and 5) on the 1-inch scale, photo-zincographed; and Chittagong (in two sheets), Darbhanga, Darrang, Dinájpur, Hissar, Jhelum, Cooch Behar State, Malda, Monghyr, Ráwalpindi, and Singhbhum; all on the 4-mile scale, lithographed.

Two hundred and ninety standard sheets of the Topographical and Revenue Surveys, on the 4-inch, 2-inch, 1-inch, $\frac{1}{2}$-inch, and $\frac{1}{4}$-inch scales, were taken in hand either for re-printing or as new publications. Eighty plates were printed off, including 28 sheets, on the 1-inch scale, comprising three of Bombay, eleven of Upper Burma, seven of Central India and Rájputána, five of the Central Provinces, and two of the North-Western Provinces and Oudh. Two sheets of the Punjab Survey, on the 2-inch scale, and 20 sheets of the Lower Burma survey and twelve of the North-Western Provinces and Oudh, on the 4-inch scale, were printed off. Of the trans-frontier surveys, twelve sheets of the North-West

trans-frontier survey, on the ½ inch scale, four sheets of the South-East frontier survey, and two sheets of the North-East frontier survey, all on the ¼ inch scale were also printed off.

The city and cantonment maps dealt with during the year comprised maps of the city and cantonment of Dacca, on the 12 inch scale; cantonment and environs of Jullundur, on the 6-inch scale, plan of Jhábua and environs, on the 6-inch scale; plans showing the old entrenchment and the new position at Lucknow, and the entrenched position of the British garrison at Lucknow, on the scale of 1 inch=400 feet; and a plan of Ráwalpindi cantonment, on the 6-inch scale, all photo-zincographed.

The following technical charts were photo-zincographed:—Triangulation chart of the Khási Hills, chart to illustrate a report on the Assam triangulation, and a chart of the triangulation in the Northern Shan States.

Among miscellaneous departmental publications may be mentioned three maps pertaining to the Burma-China Boundary Commission, on the ½-inch and ¼-inch scales, and a map to accompany the report of the Commission, on the ½-inch scale, all photo-zincographed. A map of the Eastern Nágá Hills and Manipur, with the adjoining portion of Burma, on the ¼-inch scale, and a map pertaining to the Northern Party, Burma-China Boundary Commission, on the ¼-inch scale, were photo-zincographed and proofs supplied. A large number of sheets of the various forest surveys were as usual photo-zincographed and printed off.

372. The number of extra-departmental subjects, received and put in hand during the year, amounted to 1,521, as against 1,102 last year, and the number of copies printed was 693,729, against 445,329. Much of this work was of a very urgent nature, and it has been found impossible to comply with the increasing demands for work received from other departments during the past year, without unduly delaying the reproduction of important departmental maps. The strain falls chiefly upon the compositors employed in setting up type-transfers of headings and foot-notes, and upon the zinc-correctors. The Office has for some years past been weak in these two sections, and it is now certain either that the establishment must be strengthened in these respects, or that a certain proportion of the extra-departmental work sent in must be declined. To enable the Office to comply with all demands upon it without accumulating arrears, at least seven new posts should be added to the lower grades of the Third Division, to be held by three compositors and four zinc-correctors; and the Head Zinc Printer should be given two more presses for transferring and proving, with the required extra printers, zinc grainers, and pressmen.

The largest and most important piece of extra-departmental work taken up during the year was the railway and canal map of India, in six sheets, on the 32-mile scale, which was undertaken at the instance of the Government of India, Public Works Department. It is intended that this map shall supersede the old 32-mile railway map. Considerable progress was made with it, but owing to several changes introduced in the manner of delineating the canals and irrigated areas, it will take some time to complete. It is hoped that the map will be published during the ensuing year. A map of India, showing railways sanctioned during the administration of the several Viceroys, from 1845 to 1895, was lithographed in four colours, and 1,750 copies supplied.

For the Government of India, Home Department, a map of India on the 192-mile scale, showing British Provinces and native states, was photo-zincographed, and 450 copies printed; also four maps illustrating the quinquennial review on education.

For the Government of India, Revenue and Agricultural Department, a map of Eastern Turkestan, to illustrate a report on Central Asian antiquities by Dr. Hœrnle, C.I.E., was lithographed and 50 copies printed; this map was afterwards re-printed for the Journal of the Asiatic Society of Bengal. Four plans of the Paris Exhibition of 1890 were photo-zincographed, and 13,000 copies of each printed off.

For the Government of Bengal, Public Works Department, a map of Bengal showing railways, canals, and canalized rivers, was lithographed in colours, and 750 copies printed.

For the Quarter-Master General in India, a military map of India, in six sheets, on the 32-mile scale, was lithographed in colours and proofs supplied. The proofs have been returned with many additions which are now being carried

out. For various military authorities, maps of the country, 10 miles round Ráwalpindi, Karáchi, Calcutta, Pesháwar, Delhi, Attock, and Jhelum, were prepared and printed off, and also maps for manœuvre purposes of Goona, Attock, and Allahabad. For the Adjutant General, Bengal Command, a military map of the Bengal Command was photo-zincographed and 400 copies supplied. Also 29 sketches pertaining to a staff ride between Meerut and Delhi, and 12 similar sketches of a staff ride between Lucknow and Cawnpore, lithographed in colours, and 100 copies of each printed.

For the Secretary to the Plague Commission, Bombay, a number of charts pertaining to plague inoculation were lithographed, and 7,830 copies supplied; also various maps and diagrams for the same purpose, either lithographed or photo-zincographed, of which copies were printed to the number of 30,150.

The sheets of the Rangoon town survey were proceeded with during the year, and 173 sheets were transferred to zinc and proofs supplied.

For the Meteorological Department a very large amount of work was done as usual; 115 maps and charts were either re-produced or re-printed, and 205,371 copies supplied.

373. In the Heliogravure Section the principal items of work comprised 19 plates of ancient manuscripts, coins, etc., to illustrate Dr. Hœrnle's work on Central Asian Antiquities, and 850 copies of each were printed. Many of the originals were much discoloured by age, and were particularly difficult subjects for photographic re-production. Twenty-seven plates were photo-etched, to illustrate Mr. E. W. Smith's archæological report on the Moghul colour decoration of Agra, from which 650 copies of each were printed. For the Technical Art Series 12 plates were photo-etched, and 1,000 copies of each printed. In consultation with the Superintendent of the Calcutta School of Art, it was decided that specimens of metal work should form the principal subjects in this year's series, instead of confining it to architectural subjects, as in the past, and it is proposed that next year's series shall be wholly devoted to metal work designs. Seventy-eight Enamelline half-tone blocks were prepared, from which 12,100 copies were printed in the Type Section. These include 29 blocks to illustrate the Gazetteer of Upper Burma, by Mr. J. G. Scott, C.I.E., and 17 to illustrate a report on the Peryar project. The process of electro-deposition for correcting hand-engraved copper-plates, described in last year's report, was used with success throughout the year, and ten plates were dealt with in this way. The total outturn of the section is much larger than in any previous year.

374. The scheme for the reorganization of the office, which provides for the amalgamation of the establishment with that of the technical sections of the Trigonometrical Branch Office at Dehra Dún, and for the abolition of most of the posts on progressive salaries, was sanctioned by the Secretary of State during the year, and came in force on the 1st December 1898. So far the experience of its working shows it to be completely successful.*

MAP RECORD AND ISSUE OFFICE.

375. The charge of this office was held at various times during the year, as shown in the *personnel*, by Mr. A. E. Spring, Deputy Superintendent, 1st grade, Major J. M. Fleming, Superintendent, 2nd grade, and Mr. E. Litchfield, Deputy Superintentent, 2nd grade.

Personnel.

Mr. A. E. Spring, Deputy Superintendent, 1st grade, in charge from 1st October 1898 to 6th July 1899, from 30th August 1899 to 12th September 1899, and from 28th September 1899 to 30th September 1899.

Mr. E. Litchfield, Deputy Superintendent, 2nd grade, from 7th July 1899 to 29th August 1899.

Major J. M. Fleming, Superintendent, 2nd grade, from 13th September 1899 to 27th September 1899.

Mr. F. A. D'Rozario, Head Clerk.

„ H. R. Vallis, Map-Curator, and 16 other clerks.

* Mr. Pope reports that Mr. R. Fogarty, Head Assistant, Litho. Branch, has continued to perform his duties with zeal and intelligence, and that Mr. H. Haward, Head Assistant, Photo. Branch, has worked satisfactorily. Mr. A. W. Turner, Photo-engraver, has carried on the work of the Heliogravure Section with his usual ability. Sergeant F. R. Vandyke, R.E., Foreman Litho. Printer, was on leave during the greater part of the year, but while present continued to perform his duties efficiently.

In the Second Division, Mr. E. A. LeFranc, Head Zinc Printer, has worked most assiduously; and Messrs. George, Lagnier, MacKenzie, Meade, Michael, Andrews, Murphy, Gonsalves, and Vieux, in the Photographic Section, and Messrs. DePyvah, Ravenscroft, Rodrigues, Babu A. C. Mookerjee, and Munshi A. Mujid, in the Lithographic Branch, all deserve commendation for good work. The apprentices, Messrs. DeSilva, Francis, Wilson, and Aratoon, have made good progress.

The following members of the Third Division may be specially mentioned: Mohamad Yasin, Abdul Hakim, Hyder Ali, Dino Nath Dass, Enayatullah, Gossain Dass Nath, Golam Jelaney, Abdul Wadood, Abdul Ali, Abdul Aziz, Akhoy Kumar Nath, and Ashutosh Dass.

Of the clerical staff, Babu K. L. Sen, Head Clerk and Accountant, has performed his duties efficiently, and Babus K. M. Dass, G. C. Mookerjee, S. K. Banerjee, R. K. Chatterjee, N. N. Mukerjee, and M. N. Biswas have all worked well.

376 The number and value of maps issued during the year are as follows:—

Maps issued.	Number.	Value.
		₹
General maps to Government officials	62,494	46,226
Ditto to India Office, London	11,460	12,495
Ditto to Private individuals	6,399	5,338
Ditto to Agents	2,286	3,018
TOTAL	82,639	67,077
Cadastral maps to Government Officials	112,209	1,48,118
GRAND TOTAL	194,848	2,15,195

During the year under review, there has been an increase in the number and value of maps issued when compared with those of the preceding year, which numbered 156,523, valued at R1,17,942, whereas during 1898-99 they were 194,848 in number and R2,15,195 in value, showing an increase of 38,325 in number and R97,253 in value.

The amount realized from cash sales also exceeded that of the year preceding by R1,602. The sales in 1897-98 being R19,314, whereas those of the past year were R20,916. Of this amount R9,266 were for maps sold to private individuals, R10,554 to Government officials, and R1,096 recovered from the several Agents.

The work of supplying tracings to private individuals was transferred to the Revenue Section of the Drawing Office, but this section supplied upwards of 2,000 original plans to that office for the purpose; and in addition upwards of 600 volumes of records for reference, etc., moreover 455 original volumes were received from Field Parties, of which 253 being new, were registered and sent to the Drawing Office for examination, the others being merely stored away in their respective shelves; 276 volumes and 1,100 maps were also despatched to Field Parties.

The details of work are specified in the following statement and shew a slight decrease below last year's figures, which is due to a smaller number of maps having been coloured for sale than during the preceding year:—

Details.	Number.
Applications received for maps	5,130
Letters issued in reply	4,250
Cash and credit map sale bills	1,626
Invoices and receipts issued for published maps	3,831
Ditto ditto cadastral do.	152
Packets, parcels, and local despatches	3,523
Ditto received	711
Packages despatched by rail and steamer	619
Ditto received ditto	86
Maps coloured for sale and issue	19,911
Ditto for other departments	1,832

A list of the maps and charts published during the year, copies of which have been regularly issued to the India Office and the several departments of the Government of India, and District Officers, in keeping with standing orders, will be found at page 93. *

* Mr. Spring reports that Mr. D'Rozario has continued to perform his duties to his entire satisfaction. Mr. H. R. Vallis has rendered excellent service. Messrs. J. A. Vallis, E. A. Bonnaud, S. A. Hazra, and the other clerks have also worked satisfactorily.

MATHEMATICAL INSTRUMENT OFFICE.

Personnel.

Lieut.-Colonel J. R. Hobday, S.C., Assistant Surveyor-General, in charge, from 1st April to 12th June.
Major W. J. Bythell, R.E., from 13th June to 9th August.
Captain H. A. D. Fraser, R.E., from 10th August to 12th October.
Lieut. G. A. Beazeley, R.E., from 13th to 30th October, and again from 4th February to 31st March 1899.
Major S. J. Burrard, R.E., from 31st October 1898 to 3rd February 1899.

Workshop Branch.

Mr. T. Bolton, Mathematical Instrument Maker, up to 2-th February 1899.
Mr. T. R. Theakston, Assistant Mathematical Instrument Maker, up to 28th February 1899, and Math-matical Instrument Maker, from 1st to 31st March 1899.
Mr. T. A. Fernier, Assistant Mathematical Instrument Maker, from 1st to 31st March 1899.
Two hundred and thirty artificers.

Store Branch.

Mr. M. C. Belletty, Instrument Storekeeper.
Babu W. C. Chowdhry, Material Storekeeper.

Office Establishment.

Mr. W. Campagnac, Head Clerk.
Mr. W. R. Tullock, 2nd Clerk.
Six Clerks and three temporary clerks.

377. The charge of the office was held as follows:—Lieut.-Colonel J. R. Hobday, S.C., from 1st April 1898 to 12th June 1898; Major W. J. Bythell, R.E., from 13th June to 9th August; Captain H. A. D. Fraser, R.E., from 10th August to 12th October; Lieut. G. A. Beazeley, R.E., from 13th to 30th October, and again from 4th February to 31st March 1899; Major S. J. Burrard, R.E., from 31st October 1898 to 3rd February 1899.

378. The figures in this report refer to the financial year, *i.e.*, from 1st April 1898 to 31st March 1899. During this year 61,407 serviceable instruments, valued at R2,84,208, were received into store, and 72,514 instruments, valued at R2,59,435, were issued. Compared with the preceding year this shows an increase in both number and value in the receipts; whilst the issues were considerably greater in number, but somewhat less in value as shown below:—

	1897-98.	1898-99.	Increase.	Decrease.
Number of instruments received	54,256	61,407	7,151	...
Value of ditto in rupees	2,61,816	2,84,208	22,392	...
Number of instruments issued	59,100	72,514	13,414	...
Value of ditto in rupees	2,83,857	2,59,435	...	24,422

From the above table it will be seen that the number of serviceable instruments in store has decreased by 11,107 and their value increased by R24,773.

379. The following statement shows the principal sources from which the serviceable instruments were received.—

Sources of Receipts.	Number.	Value.
From England on indent	14,624	98,368
By purchase in the local market	11,865	36,414
Manufactured in the workshop	18,574	26,902
Returned to store by public officers	12,207	14,394
From repairable stock after repair	4,118	1,07,967
From other sources	19	163
TOTAL	61,407	2,84,208

The number of instruments received on indent from England has decreased by 2,415, whilst their value has increased by R17,278, this is due to the fact

that our stock of more expensive instruments had become low and had to be brought up to the required strength. The purchases in the local market were practically the same as last year. The instruments manufactured in the workshop have increased, though their value has decreased. The manufactures depend entirely on the number of men who can be spared from the execution of repairs. The class and value of instruments will be found in Table C. in the appendix.

380. The number of instruments taken from the repairable stock and rendered serviceable for issue is less, but their value when repaired is greater than in the preceding year. This decrease in number is due to the fact that larger and more expensive instruments have been repaired.

During the year the office received 3,311 repairable instruments, valued at ₹55,760, compared with 7,644, valued at ₹92,059, in the preceding year. The total issues from the repairable stock were 4,118, valued at ₹64,132, these were repaired in the workshop at a cost of ₹43,835, and transferred at an enhanced value to the serviceable stock. The repairable stock has thus been decreased by 807 instruments, valued at ₹8,372. The decrease shows that the workshop has been able to cope successfully with the amount of repairable instruments returned to store, and at the same time to meet all current demands thereon.

381. The conversion of old pattern levels and theodolites, alluded to in para. 414 of last year's report, has been steadily continued, and during the year 71 levels of obsolete patterns have been converted into serviceable instruments. Since the increased establishment for the repair of instruments have been sanctioned, as already alluded to in previous reports, 487 levels and 192 theodolites have been rendered serviceable, and all indents for levels and theodolites, except those for railway pattern theodolites, have been complied with from this source, and indents on England for such instruments have been discontinued.

382. During the year the number of indents complied with was 1,396, being 202 less than last year. They were of the usual description and were submitted from all parts of India, from Siam, and China.

383. The cash payments for charges under ₹50, amounted to ₹50,664, being more than the previous year by ₹11,888.

384. The value of English indents for 1898-99 is £5,090, and for the previous eight years is shown in the following table, which gives some indication of the saving which is being effected by the utilisation of the extra grant for repairing instruments:—

Years.	Value of English Indent.
	£
1890-91	6,194
1891-92	8,464
1892-93	8,128
1893-94	13,875
1894-95	12,981
1895-96	5,208
1896-97	5,079
1897-98	3,995

385. Table A (in the appendix) shows the amount of debits against various officers and departments for instruments supplied and for the work done. It also exhibits the credits for all instruments and materials returned to store. The value of the issues and repairs executed on book-debit was ₹2,27,539, being ₹29,700 less than last year, this amount includes the value of instruments purchased with the extra departmental grant of ₹30,000, of which ₹28,513

s expended. The credit for instruments returned into store amounted to R68,899, which is a decrease on the previous year. The grand total of the value of supplies including the cash sales is R2,78,203, or about R17,800 less than last year.

386. The total number of instruments of all kinds repaired for public officers amounts to R5,808 or 762 in excess of last year.

387. The profit and loss account of the workshop will be found in the appendix, the result of the operations showing a nominal profit of R2,241, from which it appears that the rates for work are fairly correct.

II.—TRIGONOMETRICAL BRANCH OFFICE, DEHRA DÚN.

388. Colonel St. G. C. Gore, R.E., Superintendent, Trigonometrical Surveys, on return from special leave, took over charge of the office on the 25th October 1898, from Major S. G. Burrard, R.E. During the absence, on privilege leave, of Mr. J. Eccles, M.A., from 5th June to 2nd July 1899, Mr. C. H. Mc.A'Fee held charge of the Computing Party. Lieutenant A. Mears, I.S.C., having gone through his course of instruction in the Trigonometrical Branch, was transferred to No. 4 party on the 29th October 1898. Lieutenants H. Wood, R.E., H. McC. Cowie, R.E., B. R. Daunt, I.S.C., C. P. Gunter, R.E., E. T. Rich, R.E., and A. A. Crookshank, R.E., on their appointment to the department were attached to this office for a course of technical training. Lieutenant Daunt was attached to the office of the Superintendent, Land Records Surveys, N.-W. P. and Oudh, from

Personnel.

Superintendents.

Colonel St. G. C. Gore, R.E., Superintendent, Trigonometrical Surveys, from 25th October 1898.
Major S. G. Burrard, R. E., Officiating Superintendent, Trigonometrical Surveys, up to 24th October 1898.
Mr. J. Eccles., M.A., Superintendent, 2nd grade, in charge Computing Party, up to 4th June 1899, and from 3rd July to 30th September 1899.
Mr. C. H. McA'Fee, Extra Assistant Superintendent, 1st grade (Supernumerary), in charge Computing Party, from 5th June to 2nd July 1899.

Attached Officers.

Lieut. A. Mears, I.S.C., Offg. Assistant Superintendent, 1st grade, up to 28th October 1898.
Lieut. H. Wood, R.E., Assistant Superintendent, 2nd grade, from 16th November 1898.
Lieut. H. McC. Cowie, R.E., „ „ „ from 12th November 1898.
„ B. R. Daunt, I.S.C., „ „ „ from 31st October 1898 to 14th May 1899.
Lieut. C. P. Gunter, R.E., „ „ „ from 10th July 1899.
„ E. T. Rich, R.E., „ „ „ from 3rd July 1899.
„ A. A. Crookshank, R.E., „ „ „ from 15th July 1899.

(1) Computing Section.

Mr. A. D. L. Christie, Extra Assistant Superintendent, 2nd grade.
„ J. M. Kennedy, „ „ „ 6th grade, from 24th Nov. 1898 to 14th September 1899.
Babu Amba Prasad and 8 other Computers, 2 Copyists and 2 Writers.

(2) Printing Section.

11 Press Assistants and 2 Distributors.

(3) Photo-Zincographic Section.

Mr. G. A. LeFranc, Assistant
13 Sub-Assistants, 16 Press Assistants, 1 Accountant, 1 Storekeeper, and 1 Despatcher.

(4) Correspondence Section.

Mr. J. Burbridge, Head Clerk, and 3 other Clerks.

(5) Stores, Workshops, and Observatories Section.

1 Writer, 1 Head Artificer, and 3 Artificers.

(6) Drawing Section.

Mr. C. H. McA'Fee, Extra Assistant Superintendent, 1st grade (Supernumerary).
„ J. A. Higgs, „ „ „ 6th grade.
15 Draftsmen and 1 Surveyor.

(7) Solar Photographic Section.

Mr. R. W. Foster, Assistant Solar Photographer (Sub. pro tem.).

(8) Training School.

Mr. W. A. Fielding, Extra Assistant Superintendent, 5th grade.
Babus Aulad Hossein, Nilmoni Chatterjee, Amar Singh, Abinash Chandra Bose, Jagdamba Prasad, and Himansu Kumar Roy, Sub-Assistant Superintendents.
Babus Pramada Ranjan Roy, Messrs. H. P. D. Morton, S. S. Fielding, P. A. T. Kenny, H. C. Stotesbury, S. F. Norman, and J. R. Newland, Probationary Sub-Assistant Superintendents.
2 Surveyors, 1 Sub-Surveyor, and 15 probationary Sub-Surveyors.

18th November 1898 to 22nd February 1899, for instruction in the work of the Revenue Branch. He rejoined this office on the 23rd February, but owing to failing health, he proceeded on leave on medical certificate on the 15th May. Lieutenants Wood and Cowie completed their course and were posted to field parties at the end of the year.

Captain H. A. D. Fraser, R.E., before proceeding to England to consult Professor Rücker regarding the Magnetic Survey of India, was posted to this office to receive instruction in the subject. Four officers from the department of the Quarter-Master General were temporarily attached to this office for instruction in exploration work, of whom two are still under instruction. Mr. J. M. Kennedy was posted to the computing section of this office on the 24th November 1898 and on the 15th September 1899 he was transferred to the N.-W. P. Drawing Office.

389. The experimental base line in the Survey Office compound was re-measured for the instruction of the newly appointed officers of the Imperial and Provincial Services, and a short base of 100 feet was laid down by two measurements for comparison of chains and wires.

The office is divided into the following sections:—

(1) Computing.
(2) Printing.
(3) Photo-zincographic.
(4) Correspondence.
(5) Stores, Workshops, and Observatories.
(6) Drawing.
(7) Solar Photographic.
(8) Training School.

(1) *Computing Section.*

390. Four instalments of field records were received during the year and stored as usual. In all 13 requisitions for data and 68 indents for forms were complied with. The reduction of the observations by Captain Deasy in his explorations in Thibet is still in progress. The examination of the four charts of the Great Arc Meridional Series, section 8° to 18°, is still in hand. A table for ascertaining horizontal distances for use with a subtense instrument was completed, also a table of places of circumpolar stars from William's college catalogue and Greenwich 10-year and 9-year catalogues. The preparation of name lists for the North-East Longitudinal Series Synoptical Volume was begun. The meteorological and magnetic observations were continued as usual.

(2) *Printing Section.*

391. The following is the progress made:—

(*a*) Tidal Volume, 76 pages printed.

(*b*) Synoptical Volumes, of the Great Arc Meridional Series, Section 8° to 18°, and Indus Delta Triangulation, 47 pages printed.

(*c*) The Solar Eclipse Report, 25 pages printed.

(*d*) A beginning was made at printing a series of professional papers to be numbered in serial order. Five pages were printed of Professional Paper No. 1 "On the projection for a map of India and adjacent Countries on the scale of 1 :1,000,000", and 32 pages of No. 2 which is a translation of M. Jäderin's "Method of measuring Geodetic Bases by means of metallic wires".

In addition to the above, a large amount of work was done in printing the letter-press for charts, headings, and foot-notes for maps, and about 45,000 copies of professional and other forms were printed.

(3) *Photo-Zincographic Section.*

392. The usual routine of map publication was carried on. The work is well up to date.

(4) *Correspondence Section.*

393. This has been conducted as usual.

(5) *Stores, Workshops, and Observatories Section.*

394. A series of observations were taken with Zenith Sector No. 2 to determine the value of the Screw of Bubble tester No. 2; and the instruments of the

[redacted]se Line apparatus were examined and cleaned. The work in the observa[redacted]ries was carried on as usual.

(6) *Drawing Section.*

395. An index to the map of India and adjacent Countries on the scale of 1 : 1,000,000 was begun. As mentioned in last year's report, owing to the mapping of No. 18 Party being very much in arrears, assistance was again rendered by this section in preparing the 4-inch sheets for reduction to half scale, and in extracting the *mauza* areas from 18 of the 4-inch sheets. The outturn will be found fully detailed in the appendix.

(7) *Solar Photographic Section.*

396. The work of this section was conducted as usual. The results obtained with dry plates have been so successful as to lead to a large substitution of them for the old wet process, and in time it is expected that they will entirely supersede the wet plates.

(8) *Training School.*

397. The training school, under Mr. W. A. Fielding, imparted instruction in theodolite traversing, triangulation, levelling, and plane-tabling, also fair mapping, projection, plotting, and the computations of the Topographical Branch. Six Sub-Assistant Superintendents, who had been employed only in the Revenue Branch, as well as the seven probationary Sub-Assistant Superintendents, and 15 probationary Sub-Surveyors were put through the school course. Of the Sub-Assistant Superintendents, two proceeded on medical leave during the course of the year owing to ill health.

Besides the above, instruction in practical plane-tabling was given to seven officers of the Imperial Service; and two Sub-Surveyors of No. 15 Party received special instruction in theodolite traversing, triangulation, and plane-tabling.

The offices were inspected by the Surveyor-General in October 1898, April and July 1899, and he was quite satisfied with the working of the several sections.*

III.—NORTH-WESTERN FRONTIER DRAWING OFFICE.

398. This office was moved to Mussooree in March last, with the object of bringing it into closer connection with the office of No. 15 (N.-W. F.) Party. Colonel R. A Wahab, R. E., held charge until the 12th July 1899, when he went on privilege leave, and Lieutenant G. A. Beazeley, R.E., held charge till the end of the survey year.

Personnel.

Colonel R. A. Wahab, C. I.E., R. E., Superintendent, 1st grade.
Lieutenant G. A. Beazeley, R. E., Officiating Deputy Superintendent, from 12th July 1899.
Mr. G. W. E. Atkinson, Officiating Deputy Superintendent, 2nd grade, up to 10th October 1898.
Mr. W. J. Cornelius, Extra Assistant Superintendent, 4th grade.
Mr. R. R. Dickinson, Extra Assistant Superintendent, 5th grade.
Mr. P. F. Prunty, Extra Assistant Superintendent, 5th grade, from 21st June to 30th September 1899.
Mr. F. E. Warde, Sub-Assistant Superintendent, 1st grade.
Mr. F. Rozario, Surveyor.
" H. Sindon, Draftsman.
Munshi Nur Baksh, Draftsman, and four other draftsmen, and one writer.

The outturn of work includes the preparation of 8 sheets on the $\frac{1}{4}$-inch scale, containing the results of the surveys executed during the North-Western Frontier Expeditions up to April 1897. These sheets are drawn as standard sheets of the Northern and North-Western Trans-Frontier Series, and they include besides new work, a large amount of old material not previously put together in standard sheets. It is intended to continue the series of sheets as material becomes available so as to complete all the frontier mapping on this scale ($\frac{1}{2}$-inch = 1 mile) as has already been done in the case of Balúchistán

* Mr. Eccles reports very highly of the work done by his assistants, Messrs. McA'Fee, Christie, Kennedy, Higgs, LeFranc, and Foster, and speaks well of the computers, draftsmen, accountant, and the head writer of the Computing Section.

The Superintendent reports very favourably of the assistance rendered him by Messrs. McA'Fee and Christie; also of the services rendered by Mr. J. Burbridge, the Head Clerk, and Babu Hira Singh, the second clerk of his office.

The Superintendent expresses his satisfaction with the work done by Mr. Fielding and Munshi Muhammad Zakaria, instructor of the training school.

East of 66th meridian. New editions of sheets 3 N. W. and S. W. of the Northern Trans-Frontier have been submitted for publication and seven more on the ¼-inch scale are in hand. Of the 8-mile sheets two have been sent in and a large amount of material has been compiled for the corrections of the sheets of S. W. Asia on the same scale, which will be taken up now that the ½-inch sheets are out of hand.

Three Sections of the 16-mile map of Afghánistán have been completed and the fourth which includes the whole of the recent work on the North-Western Frontier will very shortly be ready. The same corrections have still to be carried out on the 32-mile map of Turkestan. Eight charts of triangulations have been completed embodying all the results of trans-frontier triangulation in regular standard sheets uniform with those prepared by No. 15 Party for the country south of 32°.*

IV.—FOREST SURVEY BRANCH OFFICE, DEHRA DÚN.

399. Throughout the year the charge of the head-quarters offices at Dehra Dún was in the hands of Mr. W. H. Reynolds, Superintendent of Forest Surveys, and the following branches of work were dealt with :—

(i) Correspondence and accounts of the several provincial survey detachments.
(ii) Computations and areas.
(iii) Up-keep of the Forest Department map records of the several provinces under the Government of India.
(iv) Compilation and drawing of special maps for the Forest Department.
(v) Training of surveyors.
(vi) Other miscellaneous work for the Forest Department.

400. The up-keep of the map records of the forests in the several provinces under the Government of India, as well as Madras, has received due attention. The alterations of forest boundaries and the afforested and disforested areas notified from time to time in the several Provincial Gazettes, have been recorded on the best available maps. The forest map records for Bombay have also been taken in hand and good progress has been made in this particular branch of the work. The details of the up-keep of the provincial map records have been fully described in previous reports, hence it is not necessary to record them again; nevertheless the work continues to grow heavier year by year, as new tracts, specially in Burma and Madras, continue to be brought under Forest management, and existing forest boundaries continue to undergo constant changes owing to new or revised settlements.

401. A large amount of work of a miscellaneous nature was also turned out during the year. Under this head might be noted the colouring of 3,274 printed maps of various sorts and scales and the preparation of 440 tracings for various Forest and District officers; also 2,230 printed maps, on various scales, were cut up and mounted in book form for the use of the Forest Department and other branches of the Provincial Administration.

402. During the year 12 men were instructed in surveying, *viz.*, one in the use of the theodolite for traverse purposes and 11 in plane-tabling.†

* Messrs. Cornelius and Dickinson have worked most zealously throughout the year, and among the draftsmen, Messrs. Sindon and Rozario, and Isharl Dass deserve special mention.

† Mr. Reynolds records his high appreciation of Mr. Descube's services; he works with energy and good will and in a most systematic manner, and always succeeds in turning out a vast amount of work of an excellent quality.

Mr. Watson has also done good work in the drawing office; he is a neat draftsman and is steady at his work and reliable.

Of the Subordinate Establishment the following are specially brought to notice :—

Babu Kali Kanth Kar, as an excellent head clerk; Badri Dutt and Bamala Charan Shome have done good work in the computing office, and Tulsi Ram, Mahomed Hussain, Jadu Nath, and Munzur Ahmed are commended for their excellence in map drawing. Oodey Singh, Bhup Singh, Dalip Singh, and Oodey Ram are good Surveyors and have turned out a creditable amount of field work.

LIST OF MAPS AND CHARTS PUBLISHED AT CALCUTTA DURING THE YEAR 1898-99.

TITLE.	Scale.	Number of Sheets.	REMARKS.
ATLAS OF INDIA.	In. M.		
Sheets Nos. 1 S.E., 2 S.E., 9 N.W., 10 N.E., 10 N.W., and 39 N.E.	1=4	6	With additions to 1895.
Sheets Nos. 11 S.W., 14 S.E., 37 S.W., 48 N.E., 61 N.E., 76 N.E., 77 N.W., and 79 S.W.	1=4	8	
Sheets Nos. 31 N.W., 49 N.E., 49 N.W., 70 S.W., 126 N.W., 126 N.E., 126 S.W., and 126 S.E.	1=4	8	With additions to 1898.
Sheets Nos. 48 N.W., 48 S.E., 53 S.E., and 87 S.W.	1=4	4	With additions to 1897.
Sheets Nos. 52 S. E., 53 N. E., 66 N. E., 66 N. W., and 69 S. W.	1=4	5	With additions to 1896.
Sheet No. 69 S. E.	1=4	1	With additions to 1893.
Sheet No. 129 S. E.	1=4	1	With additions to 1891.
Sheets Nos. 48 S. W. and 66 S. W.	1=4	2	With additions to 1899.
Sheets Nos. 15, 29, 102, 119, and 120	1=4	5	With additions to 1897.
Sheet No. 30	1=4	1	With additions to 1896.
Sheets Nos. 88 and 104	1=4	2	With additions to 1898.
Sheet No. 58	1=4	1	With additions to 1893.
Sheets Nos. 111 and 115	1=4	2	With additions to 1895.
Sheets Nos. 94 and 116	1=4	2	With additions to 1899.
GENERAL MAPS.			
Burma and adjacent countries	1=32	2	2nd edition. With additions and corrections to boundaries and Railways to December 1898.
India	1=32	6	3rd edition.
India (skeleton)	1=32	6	October 1898.
PROVINCIAL MAPS.			
Upper Burma	1=64	1	2nd edition.
Bengal, Bihar, Orissa, and Chota Nágpur (skeleton)	1=32	1	
Bombay Presidency	1=32	1	With additions to Railways to February 1899.
Madras Presidency	1=32	1	With additions to Railways, etc., to September 1897.
Punjab and surrounding countries (skeleton)	1=32	1	With additions to Railways, etc., to September 1898.
Bengal, Bihar, Orissa, and Chota Nágpur (with hills)	1=16	2	With additions and corrections to Railways and boundaries to December 1898.
Upper Burma	1=16	2	2nd edition. With additions to Railways, etc., to February 1899
His Highness the Nizam's Dominions, including the Assigned Districts of Berar	1=16	2	With additions to May 1898.

Title.	Scale.	Number of Sheets.	Remarks.
District maps.	In. M.		
Bogra	1=4	1	With additions to roads, etc., to December 1897.
Chittagong	1=4	2	With additions to August 1898.
Darbhanga	1=4	1	With additions to roads, etc., to April 1899.
Dinájpur	1=4	1	With additions to roads, etc., to 1897.
Hissar	1=4	1	
Jalpáiguri and the Native State of Cooch Behar	1=4	1	With additions to Railways, etc., to October 1898.
Jhelum	1=4	1	
Malda	1=4	1	2nd edition.
Monghyr	1=4	1	With additions to Railways, etc., to January 1898.
Ráwalpindi	1=4	1	
Singhbhum	1=4	1	With additions to Railways, etc., to November 1898.
Ráwalpindi—sheet No. 4 of the Kohistán of the Sindh Ságar Doáb	1=1	4	With additions to Railways to September 1897.
Dehra Dún and Siwáliks	1=1	4	2nd edition.
Standard maps.			
Bombay.			
Sheet No. 165	1=1	1	With additions to Forests, etc., to February 1898.
Sheets Nos. 350 and 351	1=1	2	
Burma (Lower).			
Toungoo District—Sheets Nos. 272 $\frac{S.W.}{3}$; 274 $\frac{N.W.}{1}$, 274 $\frac{N.W.}{2}$ (2nd edition), 274 $\frac{N.W.}{4}$ (2nd edition), 274 $\frac{S.W.}{2}$ (2nd edition), 274 $\frac{S.W.}{4}$; 275 $\frac{N.W.}{2}$ and 275 $\frac{N.W.}{4}$	4=1	8	
Toungoo and Tharrawaddy Districts—Sheets Nos. 274 $\frac{N.W.}{3}$, 274 $\frac{S.W.}{1}$, and 274 $\frac{S.W.}{3}$	4=1	3	
Toungoo and Pegu Districts—Sheet No. 275 $\frac{N.W.}{1}$	4=1	1	
Hanthawaddy District—Sheets Nos. 279 $\frac{S.W.}{4}$ and 280 $\frac{N.W.}{2}$	4=1	2	
Pegu District—Sheets Nos. 275 $\frac{N.E.}{3}$; 275 $\frac{N.E.}{4}$; 275 $\frac{S.E.}{1}$; 275 $\frac{S.E.}{2}$; 275 $\frac{S.E.}{3}$; 275 $\frac{S.E.}{4}$; 275 $\frac{S.W.}{2}$; 275 $\frac{S.W.}{4}$; 276 $\frac{N.E.}{1}$	4=1	9	
Pegu and Tharrawaddy Districts—Sheets Nos. 275 $\frac{N.W.}{3}$; 275 $\frac{S.W.}{1}$ and 275 $\frac{S.W.}{3}$	4=1	3	

Title.	Scale.	Number of Sheets.	Remarks.
STANDARD MAPS—*continued.*	4n. M.		
Burma (Upper).			
Sheets Nos. 345, 352, 353, 360, 361, and 362	1=1	6	Preliminary edition.
Sheet No. 358	1=1	1	Preliminary edition. With additions to roads, etc., to June 1898.
Central India and Rájputána.			
Sheets Nos. 307, 379, and 474	1=1	3	
North-Western Provinces and Oudh.			
Naini Tal District—Sheets Nos. 63 N.W. 2 & 3 (in one); 63 N.W. 4; 63 S.W. 1; 63 S.W. 2; 63 S.W. 3, and 63 S.W. 4	4=1	6	With additions to June 1897.
Naini Tal District—Sheets Nos. 251 S.E. 1 and 251 S.E. 3	4=1	2	With additions to August 1897.
Naini Tal District—Sheets Nos. 251 S.W. 1; 251 S.W. 2; 251 S.W. 3, and 251 S.W. 4	4=1	4	With additions to September 1897.
Punjab.			
Kángra District—Sheets Nos. 246 S.W. 4; 247 S.W. 4; 264 N.W. 1; 264 N.W. 3; 264 N.W. 4; 264 S.W. 2, and 264 S.W. 4	4=1	7	
Kullu Sub-division of Kángra District—Sheets Nos. 307 S.W. 1; 307 S.W. 3; 308 N.W. 1; 308 N.W. 3; 308 S.W. 4; 308 S.E. 3; 309 S.E. 1; 309 S.E. 2, and 309 S.E. 3	4=1	9	
Patiála State Forests—Sheets Nos. 311 N.W. 3 and 311 S.W. 1 (in one); 311 N.W. 4; 311 S.W. 1 & 3; 311 S.W. 2; 312 S.W. 4; 312 N.W. 3; 312 S.W. 3, and 312 S.W. 3 & 1	4=1	8	
Sirmúr State Forests—Sheets Nos. 314 N.E. 1; 335 S.W. 3, and 335 S.W. 4	4=1	3	
Kalsia State Forest, Umballa District—Sheet No. 336 S.W. 1	4=1	1	
Simla Hill States—Sheets Nos. 289 N. E., 312 S. E., and 313 N. E.	2=1	3	
Gurdáspur and Kángra Districts—Sheet No. 246 N. E.	2=1	1	
Simla and Patiála States—Sheet No. 289 S. E.	2=1	1	
Sind.			
Sheets Nos. 18; 19; 20; 33; 34; 35(*a*); 19A., and 37 (in one); 37A.; 38; 57; 57A.; 77; 77A.; 87; 89; 95; 95A.; 106, and 107	1=1	20	(*a*) Preliminary edition.
North-Eastern Frontier Series.			
Sheet No. 25 N. E.	1=4	1	3rd edition. With additions to boundaries to February 1896.
Sheet No. 23 N. W.	1=4	1	8th edition.
South-Eastern Frontier Series			
Sheets Nos. 2 N. W. and 2 S. W.	1=4	2	2nd edition.
Sheet No. 2 S. E.	1=4	1	5th edition.
Sheet No. 5 S. W.	1=4	1	6th edition. With additions and corrections to June 1898.
Sheet No. 1	1=8	1	5th edition.

Title.	Scale.	Number of Sheets.	Remarks.
Plans of Cities and Cantonments.	In. M.		
Calcutta and surrounding country	1=1	3	3rd edition.
Hubli City and Environs, District Dhárwár	8=1	2	1895-96.
Jullundur	6=1	6	With additions and corrections to 1897.
Administration Report maps.			
Amráoti, Betúl, Ellichpur, Gurgáon, Hoshiárpur, Jubbulpore, Mandla Mymensingh, Nágpur, Nágpur (with hills), Narsinghpur, Nimár, Noákháli, Ráwalpindi, Seoni, Sháhpur, and Wún	1=8	17	
Bálághát, Hoshangabad, and Kángra	1=12	3	
Dera Gházi Khan	1=16	1	
Ráipur	1=20	1	Engraved.
Ráipur	1=20	1	Photo-zincographed.
Index Maps.			
To the Indian Atlas Sheets showing the sheets that have been published up to 1st October 1898	1=256	1	
Chart to the Great Trigonometrical Survey of India, showing Colonel Lambton's net work of Triangulation in Southern India, the meridional and longitudinal chains of principal triangles; the base lines measured with the Colby apparatus; the lines of the spirit levelling operations; the astronomical, pendulum, and tidal stations; the longitudinal arcs and the secondary triangulation to fix the peaks of the Himálayan and the Sulemán ranges; and the positions of Bangkok, Kandahár, etc., completed to 1st October 1898	1=96	1	
To the Standard Sheets of Assam	...	1	
To the Standard Sheets of Bengal	...	1	With additions to 1898.
Statistical maps.			
Railway map of India	1=48	4	Railways brought up to 31st March 1899.
Miscellaneous.			
Special survey of the Mahásu Range, Simla Extension	6=1	2	With additions and corrections to 1897.
Reserved Forests, Vellore and Arcot Taluks, North Arcot District, Madras	4=1	4	
Reserved Forests, Gudiyáttam and Chittoor Taluks, North Arcot District, Madras	4=1	4	
Reserved Forests, Krishnagiri Taluk, Salem District, Madras	4=1	4	
Sheets Nos. 1 to 12, 14, 16, and 18, Hosúr and Dharmapuri Taluks, Reserved Forests, Salem District, Madras	4=1	15	
Nos. 1 to 6 Pachaimalai Hills Reserved Forests, Purambalur and Musiri Taluks, Trichinopoly District, Madras	4=1	6	
Nos. 12 to 17, Jávidi Hills, Vellore and Palúr Taluks, North Arcot District, Madras	4=1	6	
Plan of the Zoological Gardens, Alipur, 1899	1=150 ft.	1	2nd edition.

Title.	Scale.	Number of Sheets.	Remarks.
CHARTS.	In. M.		
Bombay Topographical Survey—Sheets Nos. 209 and 210 (in one)	1=4	1	1892-93.
Bombay Topographical Survey—Sheets Nos. 243, 244, 275, and 276 (in one)	1=4	1	1884-90.
Central Provinces—Sheets Nos. 1, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 17, 18, 19, 20, 23, 24, 25, 26, 27, 28, 34, 35, 36, 37, 38, 39, 63, 64, 82, 83, and 84	1=2	33	
Punjab—Sheet No. 311	1=2	1	2nd edition.
Punjab—Sheet No. 332	1=2	1	
Sind—Traverse of Sheets Nos. 19, 20, 38, 47, 48, 57, 68, 88, and 89	1=2	9	
Sind—Triangulation and Traverse of Sheets Nos. 15, 16, 32, 33, 34, 37, 37A, 49, 50, 57A, 66, 67, 69, 70, 77, 86, 87, 90, 91, 95, 95A, 105, 106, 107, 108, and 109	1=2	26	
Levels in the Punjab, parts of Districts Montgomery, Sirsa, Bahawalpur, and Bikaner states, with pamphlet—sheet No. 88	1=2	1	

Title of Map.	Scale.	Number of sheets.
	In. M.	
STANDARD MAPS.		
Burma.		
Ataran Forest Survey.		
Sheets Nos. 480 N. W. 1 and N. W. 3	4=1	2
Pyinmana Forest Survey.		
Sheets Nos. 268 S. W. 1; S. W. 3; S. W. 4; 269 N. W. 1; N. W. 2; N. W. 4; S. W. 1; S. W. 3; 221 S. E. 1; S. E. 3; 222 N. E. 1; N. E. 2; N. E. 4; S. E. 2 and S. E. 4	4=1	15
Central Provinces Survey.		
Bálághát Forest Survey.		
Sheets Nos. 112 N. E. 2; N. E. 3; N. E. 4; S. E. 1; S. E. 2; S. E. 3; S. E. 4; 113 N. W. 4; N. E. 2; N. E. 4; S. W. 4; and 114 N. W. 2 (in one); S. E. 1; S. E. 2; S. E. 3; and S. E. 4 (in one); S. E. 4; 114 N. E. 2 & 4; 137 S. W. 3 and 138 N. W. 1 & 3 (in one); 135 S. E. 2; S. E. 3, and S. W. 4 (in one); S. E. 4; 136 N. W. 3; N. E. 1; N. E. 2; N. E. 3; N. E. 4; S. W. 1; S. W. 3; S. W. 4; S. E. 1; S. E. 2; S. E. 3; S. E. 4; 138 S. W. 1; S. W. 2; S. W. 3; S. W. 4; S. E. 3; 139 N. W. 1; N. W. 2 and part of N. W. 4 (in one); N. E. 1 and N. E. 3 (in one); 158 S. W. 3; 159 N. W. 1; N. W. 3, and S. W. 1	4=1	42
Bilaspur Forest Survey.		
Sheet No. 223 N. W. 3 and S. W. 1 (in one)	4=1	1
Chhindwára Forest Survey.		
Sheets Nos. 54 N. E. 2; N. E. 4; S. W. 4 and 55 N. W. 2 (in one); S. E. 2; S. E. 3; S. E. 4; and 55 N. E. 2 (in one); 71 N. E. 2; S. W. 1; S. W. 2; S. W. 4; 72 N. W. 1; N. W. 3, and S. W. 1	4=1	13
Nágpur-Wardha Forest Survey.		
Sheets Nos. 41 N. E. 1; N. E. 3; S. E. 2; 56 S. W. 2; S. W. 4; S. E. 1; S. E. 2 & 4; S. E. 3; 57 N. W. 2; N. W. 3; N. W. 4; N. E. 1; N. E. 2; N. E. 3; N. E. 4; S. E. 1 & 2; 72 S. W. 1 and part of 54 S. E. 2 (in one); 75 N. W. 3 and N. W. 4	4=1	19
Káipur Forest Survey.		
Sheets Nos. 205 S. E. 3; S. E. 4; 206 N. E. 1; N. E. 2 and 223 S. W. 1	4=1	5

Title of Map.	Scale.	Number of sheets.
STANDARD MAPS—*contd.*	In. M.	
Central Provinces Survey—*contd.*		
Saugor Forest Survey.		
Sheets Nos. 45 S.E./4; 46 N.E./1; N.E./2; N.E./3; N.E./4; S.W./3; S.E./1; S.E./2; S.E./3; S.W./4 and 47 N.W./2 (in one); S.E./4 and S.E./2 (in one); 47 N.E./1; N.E./2; N.E./3; and part of N.W./4 (in one); N.E./4; S.E./1; S.E./2; 63 N.W./4; S.W./1; S.W./2; S.W./3; 64 N.W./1; N.W. 2, 3 & 4; N.W./3; N.E./1; N.E./3; N.E./4; S.W./1; S.W./2; S.W./3; S.W./4; S.E./1; S.E./3; 65 N.W./1; N.W./2 and N.E./1	4=1	35
Seoni Forest Survey.		
Sheets Nos. 71 N.E./3; S.E./2; S.E./3; S.E./4; 72 N.E./1 and part of N.E./3 (in one); 91 N.W./3; S.W./3; 92 N.W./1 and N.W./3 . .	4=1	9
North-Western Provinces and Oudh.		
Bahraich Forest Survey.		
Sheets Nos. 129 N.W./4 and 145 N.W./2 & 4	4=1	2
Gonda Forest Survey.		
Sheets Nos. 161 S.W./4 and 162 N.W./2 (in one); S.E./3 and 162 N.E./1 .	4=1	3
Gorakhpur Forest Survey.		
Sheets Nos. 188 S.E./4; 189 N.E./1; N.E./2; N.E./3; N.E./4 and S.E./2 (in one); S.E./1; S.E./3 & 4; 190 N.E./2 and N.E./4 (in one); S.E./4 and 205 S.W./3 (in one); 191 N.E./2 and 206 N.W./1 (in one); 203 N.W./3; N.W./4; S.W./1; S.W./2; S.W./3; S.W./4; S.E./1 and part of S.E./2 (in one); S.E./3 and part of S.E./4 (in one); 204 N.W./1; N.W./3; N.E./1 and N.E./2 (in one); and S.W./3 and 205 N.W./1 (in one). .	4=1	22
Punjab.		
Chamba Forest Survey.		
Sheet No. 246 N.E./2	4=1	1
Index Maps.		
Index showing progress of Forest Surveys in the Central Provinces . . .	1=32	1
„ to the Forest Surveys in the Chamba State, 1897-98	1=8	1
„ „ Government Forests in the Ruby Mines	1=8	1
„ „ Forest Surveys in the Pyinmana District	1=8	1
„ „ Forest Surveys in Tenasserim Circle	1=32	1

Title of Map.	Scale.	Number of sheets.
	In. M.	
STANDARD MAPS—*concld.*		
Miscellaneous.		
Airadeo Range, Naini Tal Division	2=1	1
Ajmer-Merwára, showing the distribution of Forest areas, 1898-99	1=4	1
Andamans, showing the distribution of reserved Forests gazetted up to 1898-99	1=8	1
Balúchistán, showing the distribution of Forest areas, 1898-99	1=8	1
Burma, showing distribution of reserved Forests gazetted up to 30th June 1898	1=32	1
Coorg Forests, Devammachi-Mawukal Forest Reserve	2=1	1
Coorg-Dúbari Forest Reserve	1=½	1
Hyderabad Assigned Districts or Berar, Akola Taluk, Akola District	1=1	2
" " " " Chikhli " Buldána District	1=1	3
" " " " Mehkar " Buldána "	1=1	3
" " " " Amráoti District, Murtazapur Taluk	1=1	2
" " " " Wún " Wún Taluk	1=1	2
" " " " Buldána Division, Amdari Range	2=1	1
North-Western Frontier, Punjab Revenue Survey, sheets Nos. 1, 3, 4, 6, and 7, District Hazára (Forests)	1=1	5
Ránikhet Forest Sub-division Working Circles	1=1	1
" Range, Ránikhet, Naini Tal Division	2=1	1
Saumi Range, Ránikhet, Naini Tal Division	2=1	1
School Circle, North-Western Provinces and Oudh Forest Map	1=4	1

APPENDIX.

EXTRACTS

FROM

REPORTS BY EXECUTIVE OFFICERS.

Narrative Report by Captain C. H. D. RYDER, R.E., *Officiating Deputy Superintendent, 1st Grade, on the Survey Operations in Yünnan, Season 1898-99.*

Having received orders to accompany Captain Davies, Oxfordshire Light Infantry, into Yünnan, I left Bangalore on the 26th October, reaching Rangoon on the 31st. Captain Davies arrived on the 4th, and on the 8th after handing over charge of No. 21 Party, I left by mail train, reaching Katha on the 10th and Bhamo on the 11th November. At Bhamo I was kept busy arranging for transport, but we finally got away on the 16th and marching *viâ* Myothit and Nampaung, crossed the frontier on the morning of the 19th. Our party was composed as follows :—

Captain H. R. Davies, Oxfordshire Light Infantry.
Captain C. H. D. Ryder, R. E., Survey Officer.
Lieutenant Watts-Jones, R.E., Railway Survey Officer.
Two Survey of India Surveyors, Lachman Jadu and Ram Sabad.

An Intelligence Surveyor was to have accompanied us, but fell sick, and had to be left behind at Nampaung.

We each had two servants, my own two Madrassis ; Captain Davies had a North-Western Provinces Mahomedan and a Chinaman, and Watts-Jones a Goanese and a Chinaman ; four Indian *khalásis* and some Chinese coolies and interpreters completed the party. Our transport, which was on the whole satisfactory, consisted of mules with Chinese drivers. After crossing the frontier we passed a number of small Chinese stockades, with a few so-called soldiers loafing about ; however, they did not interfere with us, after seeing our passports and although at first we felt rather shy of surveying openly, neither then, nor at any other time was any obstacle placed in the way of our surveying as much as we liked.

On the 18th we reached Man-yuen, a small town with a stockade, and had our first sight of the Chinese and a first experience of a Chinese crowd and their untiring curiosity. The women here had their feet bound up, a curious sight at first, but one to which a traveller in China soon gets accustomed to. From Man-yuen, Captain Davies left us for a couple of days in order to visit Santa and the path on the right bank of the Taping, and Watts-Jones and I marched straight up the valley, crossing the river about 200 yards wide by ferry. After two days' march we halted to allow Captain Davies to catch us up and then continuing up the Taping valley, or rather one branch of it, we reached Momien on the 26th.

The following day we paid a long visit to the Ting Kuan (magistrate) and were regaled with Peek and Frean's biscuits and green chartreuse. Here I first noticed the long finger nails on which a literary Chinaman prides himself, as a sign that he has never had to do any manual labour. The Ting-Kuan, however, showed us that his long nail had its advantages, as with its help and with great deftness he picked a fly out of Watts-Jones' chartreuse much to the latter's disgust.

That night I was able to take longitude observations with Captain Pirrie at Bhamo, but with some difficulty, as my star observations were executed before a noisy spitting

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crowd of Chinese, and the telegraph operations were not improved by being carried on at my end in a room in which the Telegraph clerk had invited several friends and his family to watch the performance. One of the sights of Momien is a waterfall about 60 feet high, about a mile outside the town, down which it is said the Chinese threw 500 Mahomedan prisoners at the close of the rebellion.

At Momien we again separated, Captain Davies leaving on the 29th to explore to the north, he visited Si-lien and Pa-lien, and reached Yungchang-fu by a path north of the main road; from Yungchang-fu he proceeded southwards to Tawnio, our frontier post, where he was delayed a month waiting for Mr. Turner and Mr. Ker, who had been sent out by the Yünnan company to report on the province, the former from a commercial, the latter from a mining point of view.

Lieutenant Watts-Jones and I left Momien on the same day the 29th, and reached Yungchang-fu, following the main trade route in 5 marches continuously up or down hill, and crossing the Shweli and Salween rivers by iron chain suspension bridges, distinctly creditable to the Chinese in their design and construction. Watts-Jones only stopped here a couple of days, but I was delayed a week owing to cloudy weather.

Six marches through jungly country took us to Shunning-fu and two more to Yünchon, a small town, but one that will be of importance, as it is the first town in Chinese territory on the line of the proposed railway. My interpreter, Haroon, was a native of this place and he had many marvellous stories to relate of the fighting between Mahomedans and Chinese during the rebellion. From here turning towards our frontier, the country becomes more Shan-like in appearance and after a few marches Shan villages are met with. The path does not follow the Nam Ting valley, as the railway will, but keeps on the hills to the south. On the 26th I caught up Watts-Jones at Man-hkü, a small Shan village; he had been exploring the Nam Ting valley and found it possible for a railway but not good.

After a day's halt at Mong-hsa and an excursion for a couple of days on the road towards Kunlong, I struck over the hills by a little used path for Mienling, which I reached on the 6th, crossing one range at 9,500 feet. From Mienling I made for Ching-tong-ting, by a very rough path, crossing the Mekong by ferry at Kali-kai.

The headman of this and the surrounding villages had an unenviable notoriety, one of his proudest feats having been the drowning of 13 Panthays in the river, as they were escaping from the Chinese. On January 16th I got into the valley, narrow but well cultivated, of the Black river and following it up, in two days reached Ching-tong-ting. Here I found two missionaries, Messrs. Nichols and Sanders, and was glad to meet a European again. I then followed up the valley to its source for several days, crossed over a watershed to Nantien on the 26th; here I heard that Watts-Jones, who had returned from Mong-hsa *viâ* Yünchon had passed through some days before: two days more brought me to Meng-hua, a fairly large town in a good plain, and two more to Hsia-kuan at the foot of the Tali plain. I had a very fine view of the Tali lake, crossing a watershed at 8,700 feet and looking straight down on to the lake; it was bitterly cold as snow was falling, but the view was magnificent. The lake some 30 miles long by 4 to 7 wide is encircled by hills, those to the west being covered with snow and rising to 14,000 feet.

A short march, snow hills to the left and lake to the right, brought us to Tali-fu. Meeting Watts-Jones on the road, I persuaded him to return and come northwards with me as he had been several days in Tali-fu, I only allowed myself a day's halt which was well filled up by calls on the officials, seeing the missionaries and longitude observations.

Leaving Tali-fu on the 3rd February, we reached the Yangtze on the 11th having to halt two days *en route* for the Chinese New Year. The country we passed through was a succession of well cultivated plains over 7,000 feet in elevation. We had good shooting as the plains were full of duck and the hill sides crowded with pheasant. The cold was very great, my thermometer marking 19° of frost one night. A short march down the right bank of the river here, 6,000 feet above sea-level, and a long up hill march the following day, brought us to another fine plain, Li-Chiang-fu 8,000 feet in height, with a splendid snow-clad mass of mountains to the north, over 18,000 feet in height. Our reception in Li-Chiang-fu was not cordial, but we halted a day there. On the 15th we left, Watts-Jones marching southwards to Hoching and the main trade route from Tali-fu to Yünnan-fu. I proceeded eastward, crossing a range at 10,500 feet and then descending very abruptly to the Yangtze, which was crossed by a chain suspension bridge in a very bad state of repair. On the 17th, while on the march, my mule men got into a row with another set of mule drivers connected with some copper mines in the neighbourhood, one of the men, not mine, was nearly killed and his comrades went off vowing to bring the rest of the miners to attack us that night; however, the night passed over without incident and a forced march took us to Yungpe-ting the following day, where I settled the matter satisfactorily with the Chinese officials.

The next six marches were very much up and down, crossing affluents of the Yangtze several times. I had fine views northwards, the country apparently one mass of hills, many of them under snow. At Chin-ya-pin I came upon some very good coal, which was being used in all the houses for fuel; and the next day, the 26th, after a short march reached the Yangtze again at Machang, where I found two French priests who very hospitably insisted on my stopping the night with them. They informed me that a great deal of coal existed in the neighbourhood. I then followed the left bank of the river until I crossed it on the 28th at a height of 3,500 feet. The river here is fast running, about 150 yards wide, and a small quantity of gold is found in the sand. After crossing the

urned south and reached Tsu-hsiung on March 11th, meeting Captain Davies, enant Watts-Jones, and Mr. Ker two days previously. Here we halted six days while got my longitude observations; the main party then went into Yünnan-fu by the main road, I marching by a route more to the south. Mr. Ker, with whom I sent Surveyor Ram Sabad, left Tsu-hsiung for the north going up to Hui-li-chon and returning to Yünnan-fu, early in May. Yünnan-fu, the capital of the province, where we arrived on the 24th, is a fine large town, walled as all the Chinese towns are, and contains some 50,000 inhabitants. The trade in foreign goods is nearly all carried on with Tong King, but a great many goods of English manufacture come that way. Here I was obliged to stay 28 days, trying in vain to get direct telegraphic communication with Bhamo for longitude, but it ended in a failure owing to the incapacity and laziness of the clerks at intermediate stations. In the mean time Captain Davies and Lieutenant Watts-Jones left by different roads for Weining and Pichich-hsien, near where they finally met Captain Pottinger's party who had been much delayed by the weather and by the hostility of the Chinese. Captain Davies then returned to Yünnan and marching on the direct road to Mongtzu-hsien came out down the Red river. I finally left Yünnan on the 23rd April and marching south-east visited several fair sized towns, but their trade is small and the country generally poor. On the 4th April I reached Mongtzu-hsien, a place comparatively civilized, there being a French Consulate as well as a Chinese customs station. Mr. Spinney, the head of the customs, kindly put me up and I halted 3 days there expecting letters. However, none came, so I left on the 7th, 4 days taking me to Kai-hua-fu and five more down to Lad kai on the Red river, and the French frontier station. Here I got a boat and two days down stream brought us to Yen-bai, where I had to wait a couple of days for the steamer, then three more days took us to Hai-phong, the port of Tong King, from where I found a steamer going to Hong Kong and so to India by P. and O.

The results of our trip were as follows:—

Some 44,000 square miles of country were surveyed on the ½-inch scale, of which the Survey of India may take credit for 29,000 square miles. A possible route for a railway has been found in continuation of the Kunlong line, and a great deal of miscellaneous information has been collected about the country. I have the pleasure of recommending very highly the two surveyors who accompanied us—Lachman Jadu and Ram Sabad. They both worked untiringly and with great energy in a country, where the people were foreign to them and very often unfriendly, and their traverses checked by the longitude and latitude observations were generally found very good. I also wish to mention the very excellent work done by my interpreter Haroon. In addition the longitudes of Momien, Yungchâng-fu, Tali-fu, and Tsu-hsiung-fu were fixed by telegraph and over a hundred latitudes were observed.

During the field season 1899-1900, another expedition, will be sent into Yünnan. consisting of Captain Davies, Oxfordshire Light Infantry, Captain Ryder, R. E., Survey of India, and Major Manifold, I. M.S., each accompanied by a surveyor; Captain Rigby of the Wiltshire Regiment and Lieutenant Fraser, R.A., each also accompanied by a surveyor, will also be exploring in Yünnan, so that by the end of the season a fairly complete map and Gazetteer of Yünnan will be available.

Narrative report by CAPTAIN T. F. B. RENNY-TAILYOUR, R.E., *Offg. Superintendent, 2nd grade, on the Survey operations with the Burma-China Boundary Commission, Northern Section, season 1898-99.*

It was again decided to send two parties to demarcate the Burma-China Boundary, one working at the northern end and the other at the southern end, leaving in the centre the frontier between the Wa country and China for next season.

The distance between the parties was so great that, as far as actual survey operations were concerned, they were practically independent of each other, and Captain H. J. Hare, R.E., who was in charge of the Survey Detachment with the Southern Party, is submitting a separate report.

Captain T. F. B. Renny-Tailyour, R.E.
Surveyor Mahmud Husain.
" Abdul Rahim.
Sub-Surveyor Mowni Ram,
39 *Khalásis*, Interpreters, etc.

} The Survey detachment detailed to accompany the Northern Party is given in the margin.

Mr. J. C. Scott, C.I.E., was the British Commissioner and accompanied the Northern Party. Mr. J. W. Jamieson, of the China Consular Service, was the Chinese Adviser and the following officers were posted to the party:—Lieutenant-Colonel Lloyd, V.C., R.A.M.C., as Medical Officer, Captain H. B. Walker, D.C.L.I., as Intelligence Officer, Captain R. C. Dundas, the Royal Scots, as Signalling Officer after Namhkam, and Captain J. L. W. Ffrench-Mullen, 13th B. L., as Signalling Officer up to Namhkam, 25 Sappers and Miners of the Burma Company were also sent.

General Liu was again the Chinese Commissioner, he was accompanied by Mr. P'eng, several other civil officers and a fairly large escort. Our programme was to demarcate the boundary from the Taping river in a south-easterly direction as far as the Nam Ting (river).

We left Bhamo on the 28th November, arriving at Nampaung on the 30th, rea[illegible] meet the Chinese Commission on the 1st December, as had been previously settled. [illegible] Rae, the Civil Officer in charge of this part of the Bhamo district, joined us here.

My arrangements for the survey operations were :—To do the triangulation myself, Mahmud Husain to survey as much as possible along the frontier and in China on the ½-inch scale, Abdul Rahim to survey the boundary on the 1-inch scale, and to fix the position of each of the boundary marks, and Mowni Ram to assist with the survey on the 1-inch scale, when necessary, and at other times to survey on the ½-inch scale. There was already a certain amount of triangulation as far as Namhkam, but practically none at all beyond ; I intended to push on as fast as possible, strengthening the work up to Namhkam and completing the triangulation to the end of our portion of the boundary before the haze set in, and expected to be away from the party for at least two months.

On the 1st December we exchanged calls with the Chinese and held our first official meeting on the 2nd. Questions referring to maps were constantly cropping up, and after consulting with Mr. Scott I found it was impossible for me to go on ahead with the triangulation as I had intended. This was rather a serious matter, as with the haze in the latter part of the season, it was most improbable that I should now be able to carry my triangulation right through, and it would be extremely unsatisfactory to survey the boundary on the 1-inch scale without fixed points. I accordingly applied to the Surveyor-General and asked him to arrange for triangulation being carried from the Nam Ting northwards, along the Kokang boundary, by Mr. Adams of No. 21 Party.

Nampaung is a low and feverish place, and I was very glad when we left it on the 7th December. After halting several days *en route*, we arrived on the 16th at a very confined camp, more or less in the centre of the disputed country.

We left this camp on the 24th December, and arrived at Loileng on Xmas day. There was first rate camping ground at Loileng, and the main body of the escort marched in on the 26th December, having come from Bhamo by another and more direct road.

Just beyond Loileng the boundary became rather complicated, running across fields near the edge of the Mêng Wan plain, and in order to decide on the best line we moved to Homun on the 5th January. At Homun we settled the boundary down to the Nam Wan, which river it then follows to the Shweli river near Namhkam.

Up to date I had made and observed from 4 stations, but to obtain a satisfactory connection, it was necessary for me to visit and observe from 2 hills, to the west of the road from Homun to Namhkam ; Naru Pum, one of these hills, was nearly 8,000 feet elevation and the highest in this part of the country.

The line being now settled so far in advance, gave me an excellent opportunity of doing this work. I accordingly left Homun on the 7th January and rejoined the Commission, a march before Namhkam, which place we arrived at on the 15th.

In the Mêng Wan plain we had made considerable concessions to the Chinese, on the understanding that they would give us corresponding concessions in the Shweli Valley, near Namhkam, and further on in the neighbourhood of Möng Ko. In order to decide what these concessions were, I sent Abdul Rahim to survey the Shweli Valley, and Mahmud Husain with a strong escort was sent to survey at Möng Ko and beyond.

On Abdul Rahim's return we settled the boundary line for the Shweli Valley, and decided to move on slowly, demarcating it leaving the Möng Ko question until our arrival there.

At Namhkam, which is in the Northern Shan States, Mr. Rae left us and Mr. Breithaupt took his place. The main body of the escort followed us to Namhkam, but never advanced beyond and returned to Bhamo soon after we moved on.

The Commission left Namhkam on the 26th January and arrived at Möng Ko on the 8th February.

The 10th February was the Chinese New Year ; we sent them presents and returned calls in honour of the occasion. Several conferences were held at Möng Ko and after considerable discussion, the boundary line was settled down to the Salween river.

Since our arrival at Namhkam, I had been able to get away from the Commission on several occasions for short periods, and being lucky in the matter of weather, had managed to observe from a good number of stations, and had carried on the triangulation as far as MöngKo, besides fixing a certain number of points in advance.

From Möng Ko it was decided that the Commission should proceed to Mêng P'êng, an important Chinese village, with good camping ground, and not far from where the frontier line along the boundary of the sub-state of Kokang leaves the Salween river. The direct road through our territory is extremely hilly and the Chinese being anxious to entertain the Commission at Mêng Ka, Mr. Scott decided to go round with General Liu through China, taking about a fortnight *en route*. At the same time Mr. Jamieson persuaded the Chinese to allow Captain Walker with a surveyor to take a month's trip through China, travelling by a different road to the Commission. I took advantage of these opportunities to send Abdul Rahim with Mr. Scott, Mahmud Husain with Captain Walker, and Mowni Ram by the direct road to Mêng P'êng near the frontier.

In the mean time I had heard that it was impossible for Mr. Adams to carry on his triangulation more than a few miles north of the Nam Ting, and that practically I should get no help from him ; under the circumstances my only chance was to make a dash into Kokang while the Commission was going round through China and try and run my triangulation as far to the east and south as possible ; this I did and having the good fortune to get some rain, the haze partially cleared off and I was able to do a lot of work.

[illegible]ied observations from 9 stations, and fixed a number of points in China, and along the boundary to within 10 or 12 miles of the Nam Ting. I had certainly extremely good luck, as the day after observing from my last station, the haze became like peasoup.

I arrived at Mêng P'êng on the 17th March within an hour or two of the Commission, who had had a very good time in China; the Chinese had been most hospitable and entertained them in great style; at Mêng Ka' the programme included a variety show which was made particularly amusing by each of the members of the Commission taking a turn!

After staying a few days at Mêng P'êng to settle details about the boundary, the Commission moved on slowly, eventually arriving at Tashuit'ang on the 6th April. Tashuit'ang was within about 6 miles of the Capital of Kokang and delightfully cool. Owing to the early commencement of the rains in this part of the country, the haze cleared away considerably during April, and enabled me to form 3 more stations in connection with my others in Kokang, and to fix sufficient points to carry the survey accurately down to the end of the boundary on the Nam Ting.

The demarcation of the Kokang boundary progressed rapidly, and the last boundary mark was put up on the 18th April.

The duplicate 1-inch maps for signature by the Commissioners had been taken in hand soon after our arrival at Tashuit'ang, they were completed by the 22nd April, and the final meeting for attaching seals and signatures took place the following day.

Our social relations with the Chinese were very cordial, and before parting we did our best to return the hospitality they had shown our party when in China. Among other entertainments we gave them a dinner and a musical evening. On the completion of the work, Mr. Scott started off to interview the Viceroy of Yünnan, with reference to next season's delimitation. Mr. Jamieson went off to Ssümao, joining Mr. Scott at Yünnan.

Captain Walker obtained leave from General Liu to return to Burma *viâ* T'êngyüeh (Momien) and the Kambaiti pass, and Mahmud Husain accompanied him.

The remainder of the Commission left Tashuit'ang on the 26th April and marched back to Bhamo, arriving there on the 16th May. The march back was rendered somewhat unpleasant, owing to the fact that the rains had now more or less set in, and we got soaked through on several occasions.

Our transport during the season was composed of Chinese and Government mules, but it is to be hoped that only Chinese mules will be employed next season, as with a Commission like ours Government mules are decidedly objectionable. Mr. Scott takes a great interest in survey work and did his utmost to assist us. I am also greatly indebted to Mr. Jamieson, whose influence with General Liu was invaluable, and to Captain Walker who took every advantage that was offered to make reconnaissances into China, always taking one of my surveyors with him and doing everything he could to facilitate the mapping. After the first few days the surveyors were continuously employed and I consider we had a very successful season. Triangulation was carried on throughout, and besides plenty of points along the frontier, a number of distant hills were fixed in China; altogether 33 stations were observed from, and in addition, 170 intersected points were fixed.

The boundary line, which was nearly 300 miles in length, was accurately surveyed on the 1-inch scale; by working out my triangulation roughly in the field I was always able to supply the surveyors with fixed points.

Every opportunity was taken advantage of to survey in China, and nearly all the country surveyed on the ½-inch scale was across the frontier.

The following are the areas completed after deducting overlaps:—

Triangulation, 4,000 square miles.
Plane-tabling on 1-inch scale, 1,300 square miles.
Plane-tabling on ½-inch scale, 7,500 square miles.

In recess at Bangalore the triangulation has been carefully computed, and as my last two stations were also observed from by Mr. Adams (whose work is based on the triangulation brought up by No. 21 party from Mandalay), a very good check was obtained, and I am glad to say the connection is very satisfactory, the differences being only about 2 seconds in latitude, 1 second in longitude, and 30 feet in height.

The 1-inch work has been fair mapped in 8 sheets and the ½-inch work has been fair mapped on the ordinary ½-inch sheets.

The country passed through was hilly, moderately open, and appeared to be very healthy in the cold weather; the climate, on the whole, was cool and pleasant, and consequently the general health of the Survey Detachment was very good.

Surveyor Mahmud Husain surveyed an area of 7,300 square miles on the ½-inch scale. He is an accurate and experienced surveyor, and considering that he is 55 years of age, marvellously active and hard working.

Surveyor Abdul Rahim surveyed an area of 835 square miles on the 1-inch scale and an area of 1,400 square miles on the ½-inch scale. He is a particularly quick surveyor and worked very well. He was always on the best of terms with the Chinese, thereby considerably facilitating the work.

Sub-Surveyor Mowni Ram surveyed an area of 480 square miles on the 1-inch scale and an area of 1,000 square miles on the ½-inch scale. He is a good surveyor and worked well.

Narrative report by CAPTAIN H. J. HARE, R. E., *Officiating Deputy Superintendent, 2nd grade, on the Survey Operations with the Burma-China Boundary Commission, Southern Section, Season 1898-99.*

The boundary line to be demarcated by the Southern party of the Burma-China Boundary Commission extended from the south of the Wa country to the Mekong river.

Captain H. J. Hare, R.E., Officiating Deputy Superintendent, 2nd grade.
Sub-Assistant Superintendent Ikbaluddin.
Sub-Surveyor Kudratulla.
Sub-Surveyor Jamna Pershad.

The *personnel* of the survey detachment with the party is given in the margin.

Mr. E. C. George, C.I E., was the British Sub-Commissioner, with Mr. P. F. Hausser of the China Consular service as Chinese adviser.

The following Officers also accompanied the Commission :—

Major S. N. Caulfield, D.S.O , 1st Burma Gurkha Rifles, as Signalling Officer.

Capt. J. K. Tod, 7th Bengal Cavalry, as Intelligence Officer.

Mr. C. B. Sterling, as Civil Officer.

Lieutenant J. Whitehead and later Lieutenant H. G. Corbett, 3rd Burma Regiment, Commanding the escort, and Lieutenant H. Sant Fournier, of the Essex Regiment, as Transport Officer.

The escort consisted of 130 men of the 3rd Burma Regiment from Kengtung, and a detachment of 25 men from the Burma Company of the "Q. O." Sappers and Miners.

The Chinese Sub-Commissioner was Chen Tsan from Pu-erh, and he was accompanied by several Military and Civil officials from his district. He also was accompanied by an escort of 150 men or more when we first met him, but this was considerably reduced towards the close of the work.

The party started from Mandalay on November 20th, but halted at Maymyo owing to Mr. George being unexpectedly delayed. This was a very late start and meant that the Commission could not get to work before the end of December.

As I had to start triangulation from the Salween and carry it up some 50 miles to where the boundary work would start, I decided to push ahead of the Commission and eventually reached Na-Lawt on 21st December, 3 days in advance of the rest of the party.

We found that the Chinese had arrived and were encamped two miles off at Mong Nga across the Nam Hka, and on the 26th December we moved across to their camp and paid the usual official calls.

The total length of boundary to be laid down was 225 miles. No triangulation existed along it until near the end, where I hoped to connect with a series brought up from Kengtung by Mr. Shaw for the purpose.

The haze would set in about March 1st, after which date, I could not count on being able to take any observations, consequently I was anxious to push on ahead of the Commission, and this Mr. George very kindly arranged for me to do.

The Commission did not leave Mong Nga until the 25th January, having spent a month endeavouring to come to an understanding with the Chinese over the first few miles of the boundary. The country in dispute lay on the steep slopes of Loi Ang Lawng, scarcely inhabited and most difficult ground for a surveyor.

The second camp at Lah Hpok was reached on February 2nd, and 18 days more were spent before the Chinese Commissioner could be persuaded to consent to our proposals.

In all, the first two months' work resulted in only 20 of the 225 miles being agreed to. After this fewer difficulties were raised by the Chinese, and Kenglaw the half-way point of the work was reached early in March.

The remainder of the boundary up to the Mekong was agreed to on the last day in April, the survey work being completed on the 20th of that month.

Owing to the difficulties raised by the Chinese from the beginning, the Sub-Commissioner required the large scale 1-inch survey, from which to discuss the boundary line, instead of being able to settle its run from a ½-inch reconnaissance, and confining the work on the 1-inch scale to a survey of the boundary when laid down. The strength of the detachment was not of course calculated for this, and it entailed a large amount of extra work on the surveyors.

I am greatly indebted to Mr. George for the assistance he rendered to the survey work, and also to Mr. Sterling and Captain Tod whose ready help was most valuable.

The survey of the boundary was made on the scale of 1 inch to 1 mile, with the exception of where the line followed the river Nam Lam. This was mapped on the 4 miles to the inch scale, the saving of time being of great consequence and a large scale record unnecessary.

I was able to give the plane-tablers points throughout the work by computing the triangulation in the field.

In all, 30 stations were observed from, 7 of these being by Munshi Ikbaluddin. The areas triangulated being 3,578 square miles by myself and 1,146 by Munshi Ikbaluddin; total 4,724 square miles. The areas plane-tabled were 915 square miles on the 1-inch scale and 4,216 square miles on the ¼ inch.

The triangulation was carefully computed in recess at Bangalore.

Mr. C. Williams had connected on the stations from which I started near the Salween with the triangulation of No. 21 Party, and I had also a connection with Mr. Shaw's

from Kengtung. The results were extremely good, the difference being less than a second both in latitude and longitude, and within 17 feet in height.

The country throughout was extremely difficult for survey work, being very broken and hilly and covered with jungle. Until close to the Mekong I did not meet with a single clear hill, and many required a hundred coolies for two or three days to make any sort of clearing. This added greatly to the difficulties of the work and made it impossible, where local assistance was not to be obtained.

Villages were small and not very numerous, but the natives were expert in the use of the axe when they could be induced to work.

The haze set in about the 3rd March and continued till the rains broke. It was astonishingly thick and like a London fog, hiding the sun for days and making it often impossible to see more than half a mile.

The rains broke early in April and continued with scarcely three fine days until we finished our long march back at the end of June. With such a large party as ours the results to both men and animals were very bad, and the experience was not one that any of us would care to repeat.

Sub-Assistant Superintendent Ikbaluddin did excellent work for me during the time I was triangulating, in choosing and clearing stations in advance, and I consider it was largely due to his energy that the work was as good as it proved to be. He also did a considerable area of triangulation and survey on both the 1-inch and ½-inch scale. I formed a very high opinion of him and consider he is well fitted for the position he has gained in the Department. Sub-Surveyor Kudratulla was mostly employed on ½-inch work with some 1-inch survey towards the close of the season. He worked most cheerfully and willingly, and his marching powers, considering his age, are surprising.

Sub-Surveyor Jamna Pershad had a difficult position, as the principal surveyor between the Chinese and our Sub-Commissioner, and acquitted himself very well. He is a very quick worker on the 1-inch scale, and I think with more experience should make a valuable surveyor.

DRAWING OFFICE, CALCUTTA.

SECTION NO. I.—GEOGRAPHICAL, DRAWING, AND COMPILATION.

Statement showing the work performed during the year 1898-99.

TITLE.	Scale.	Number of Sheets.	REMARKS.
ATLAS OF INDIA.	In. M.		
Sheets Nos. 1 S. E., 2 S. E., 8 S. E., 9 N. W., 10 N. E., 11 S. W., 29, 30, 37 N. W., 37 S. W., 39 N. W., 44, 47 S. E., 48 N. E., 53 S. W., 61, 61 N. E., 64 S. W., 66 N. W., 67 S. E., 69 S. E., 69 S. W., 70 S. E., 70 S. W., 71 S. W., 76, 76 N. E., 76 S. E., 77 N. E., 78, 78 N. E., 86 S. E., 86 S. W., 87 N. W., 87 S. W., 88, 94, 111, 116, 119, 125 S. E., 126 N. E., 126 N. W., 128 N. E., and 131 N. W.	1=4	45	Additions made to railways, roads, canals, and changes to boundaries.
Sheets Nos. 21 N. W., 27 N. E., 40 S. E., 41 S. E., 41 N. W., 41 S. W., 42 N. E., 42 N. W., 57 S. W., 58 N. W., 58 S. W., 59 S. E., 59 N. W., 61 S. W., 62 N. E., 62 S. E., 62 N. W., 78 S. E., 79 N. E., 79 S. E., 80 S. E., 80 N. W., 80 S. W., 81 N. W., 106 S. E., 107 N. E., 107 S. E., 107 N. W., 107 S. W., 134 N. E., 134 S. E., 134 N. W., 134 S. W., 141 S. W., 142 N. E., 142 S. E., 142 N. W., 142 S. W., 143 N. E., 143 S. W., 144 N. E., 144 S. E., 144 S. W., 145 N. E., 145 S. E., 145 N. W., 145 S. W., 146 N. E., 146 N. W., 150 S. W., 151 N. W., 152 S. W., 153 N. E., 153 S. E., 153 N. W., 153 S. W., 154 N. E., 154 S. E., 154 N. W., 154 S. W., 163 S. W., 164 N. W., 164 S. W., and 165 N. W.	1=4	64	Additions made to names and details for engraving.
Sheets Nos. 14 N. E., 25 N. E., 40 S. W., 41 N. E., 41 S. E., 41 N. W., 48 N. E., 58 S. E., 59 N. W., 66 S. W., 77 S. W., 78 S. E., 79 S. W., and 159 N. W.	1=4	14	Hills brush-shaded for engraving.
GENERAL MAPS.			
Afghánistán (Photo.)	1=24	2	Boundaries to date.
Route map of Western Himálayas, Kashmir, Punjab, and Northern India (Engraved)	1=32	1	Additions to date.
India (skeleton) (showing railways) (Photo.)	1=32	6	In progress.
India (Blue print) (Litho.)	1=32	6	Additions to date.
Do. (2nd Edition) (do.)	1=32	6	Ditto ditto.
Do. (skeleton) (do.)	1=32	6	Railways to date and published.
Do. (showing railway stations) (Photo.)	1=32	6	Additions to date.
India (showing canals) (Litho.)	1=32	6	Ditto ditto.
Do. (3rd Edition) (Litho.)	1=32	6	Ditto ditto.
Do. (showing railways) (Photo.)	1=48	4	Railways to date and published.
Do. (Engraved)	1=64	4	Additions to date.
Do. (Litho.)	1=64	2	Boundaries to date.
Do. (Engraved)	1=80	1	Additions to date.
Do. (ditto)	1=96	1	Ditto ditto.
Do. (ditto) (with hills)	1=128	1	Railways to date.
PROVINCIAL MAPS.			
Bengal, Bihar, Orissa, and Chota Nágpur (2nd Edition) (Engraved)	1=16	2	Additions to date.

DRAWING OFFICE, CALCUTTA.

SECTION NO. I—*continued.*

Statement of work —continued.

TITLE.	Scale.	Number of Sheets.	REMARKS.
PROVINCIAL MAPS—*contd.*	In. M.		
Bengal, Bihar, Orissa, and Chota Nágpur (Litho.)	1=16	2	Additions to date and published.
Ditto Ditto (skeleton)	1=32	1	Ditto ditto ditto.
Bombay Presidency (Engraved)	1=16	1	Hills brush-shaded for engraving.
Ditto ditto (ditto)	1=16	1	Additions to railways to date.
Ditto ditto (Litho.)	1=32	1	Ditto to date and published.
Central India Agency (Engraved)	1=16	2	Ditto ditto ditto.
Central Provinces (ditto)	1=16	2	Ditto ditto ditto.
Madras Presidency (ditto)	1=16	4	Hills brush-shaded for engraving.
Ditto ditto (ditto)	1=16	4	Boundaries to date.
Ditto ditto (Litho.)	1=32	1	Additions to date and published.
Nepál	1=32	1	Ditto ditto.
Nizam's Dominions (Litho.)	1=16	2	Ditto to railways, roads, etc., to date and published.
North-Western Provinces and Oudh (Litho.)	1=32	1	Ditto ditto to date.
Punjab (Engraved)	1=16	4	Hills brush-shaded for engraving.
Ditto (ditto)	1=16	4	Additions to railways and boundaries.
Ditto (ditto) (skeleton)	1=32	1	Ditto to date.
Ditto (ditto)	1=80	1	Ditto to boundaries.
Rájputána Agency (Engraved)	1=16	1	Ditto to date.
Ditto ditto (Litho.)	1=16	1	Ditto ditto.
Sind (Litho.)	1=16	1	Ditto ditto.
Upper Burma (2nd Edition)	1=16	2	Ditto ditto and published.
Do. ditto (3rd Edition)	1=16	2	Compilation in progress.
DIVISIONAL MAPS.			
Chittagong	1=8	1	Additions to railways to date.
Dacca	1=8	1	Ditto ditto ditto.
Pegu	1=4	4	Brought up to date.
Presidency	1=8	1	Additions to railways to date.
DISTRICT MAPS.			
ASSAM—			
Darrang	1=4	1	Railways to date and published.
Gáro Hills	1=4	1	Brought up to date and published.
Goálpára	1=4	1	Additions to date.
Kámrúp	1=4	1	Ditto ditto.
Khási and Jaintia Hills	1=4	1	Ditto ditto.
Lakhimpur	1=4	1	Ditto ditto.
Nágá Hills	1=4	1	Ditto ditto.
Nowgong	1=4	1	Ditto ditto.
Sibságar	1=4	1	Ditto ditto.
BENGAL—			
Bogra	1=4	1	Additions to date.
Chittagong	1=4	1	Completed and published.
Darbhanga	1=4	1	Additions to date and published.
Dinájpur	1=4	1	Completed and published.
Jalpáiguri	1=4	1	Ditto ditto.
Malda (2nd Edition)	1=4	1	Ditto ditto.
Midnapore	1=4	1	Additions to date.
Monghyr	1=4	1	Ditto do. and published.
Patna	1=4	1	Ditto do.
Sháhabad	1=4	1	Ditto do.
Singhbhum	1=4	1	Ditto do. and published.
BOMBAY—			
Ahmedabad	1=4	1	Prepared and sent for Lithography.
Ahmednagar	1=4	1	Ditto ditto.
Kolába	1=4	1	Ditto ditto.
Násik	1=4	1	Ditto ditto.
Poona	1=4	1	Ditto ditto.
Ratnágiri	1=4	1	Ditto ditto.
Sátára	1=4	1	Ditto ditto.
Surat	1=4	1	Ditto ditto.
Káthiáwár Agency	1=16	1	Additions to date and published.
CENTRAL PROVINCES—			
Hoshangabad	1=4	1	Additions to date.

DRAWING OFFICE, CALCUTTA.

SECTION NO. I—*continued.*

Statement of work—continued.

TITLE.	Scale.	Number of Sheets.	REMARKS.
DISTRICT MAPS—*concluded.*	In. M.		
BURMA—			
Bhamo and Myitkyina	1=8	1	Railways brought up to date.
PUNJAB—			
Hissar	1=4	1	Completed and published.
Jhelum	1=4	1	Ditto ditto.
Peshâwar	1=4	1	Additions to boundaries.
Râwalpindi	1=4	1	Completed and published.
STANDARD MAPS.			
ASSAM—			
Sheets Nos. 28, 40, 50, and 52.	1=2	4	Completed.
BENGAL—			
Sheet No 74	1=1	1	Additions to date and published.
Sheets Nos. 2, 4, 6, 11, and 15.	1=1	5	Ditto ditto.
BOMBAY—			
Sheet No. 279 $\frac{\text{S. W.}}{3}$	4=1	1	Boundaries to date.
CENTRAL INDIA AND RÂJPUTÂNA—			
Sheets Nos. 118, 147, 206, 241, 258, 303, 306, 318, 332, 345, 379, and 471	1=1	12	Brought up to date and published.
Sheets Nos. 307, 378, 410, and 474	1=1	4	Completed and published.
Sheets Nos. 71, 347, and 408	1=1	3	Additions and corrections to date.
Sheets Nos. 108, 109, 134, and 135	1=2	1	Ditto to date and published.
CENTRAL PROVINCES—			
Sheet No. 109 $\frac{\text{N. W.}}{2}$	4=1	1	Additions to details.
Sheets Nos. 4, 8, 18, 20, and 68	1=1	5	Completed and published.
Sheets Nos. 19, 34, and 266	1=1	3	Additions to date and published.
Sheet No. 28	1=1	1	Ditto to boundaries.
Sheet No. 67	1=1	1	In progress.
HYDERABAD—			
Sheet No. 173	1=1	1	Additions to date.
MADRAS—			
Chendragiri Taluk	4=1	10	Completed and under publication.
Chittoor and Gudiyáttam Taluks	4=1	4	Published.
Hosúr and Dharmapuri Taluks	4=1	15	Ditto.
Jávidi Hills	4=1	6	Ditto.
Krishnagiri Taluk	4=1	4	Ditto.
Pachaimalai Hills	4=1	6	Ditto.
Sheets Nos. 23, 24, 50, 51, 78, 102, 104, 105, and 172	1=1	9	Additions and corrections to date.
NORTH-WESTERN PROVINCES AND OUDH—			
Sheets Nos. 63 $\frac{\text{S. W.}}{4}$, $\frac{\text{S. W.}}{2}$, $\frac{\text{S. W.}}{3}$, and $\frac{\text{S. W.}}{4}$	4=1	4	Additions and corrections to date.
Sheet No. 171	1=1	1	Completed and published.

DRAWING OFFICE, CALCUTTA.

SECTION NO. I—*continued.*

Statement of work—continued.

TITLE.	Scale.	Number of Sheets.	REMARKS.
STANDARD MAPS—*contd.*	1n. M.		
PUNJAB—			
Sheets Nos. 66 S. E., 67 S. E., 68 N. E., 68 S. E., 69 N. E., 69 N.W., 69 S.W., 70 N. W., 93 S. E., 93 S.W., 94 S.E., 94 N.W., 95 N.W., 121 S.E., 121 S.W., and 122 S.W. . .	2=1	16	Completed and published.
Sheets Nos. 69 S.E., 70 N.E., 94 N.E., 94 S.W., 122 N.E., and 122 N.W. . . .	2=1	6	In progress.
UPPER BURMA—			
Sheets Nos. 305, 307, 315, 351, 352, 353, 358, 360, 361, and 362	1=1	10	Completed and published.
Sheet No. 306 (2nd Edition.) .	1=1	1	Ditto ditto.
Sheets Nos. 304, 350, 398, 399, 402, and 458 . . .	1=1	6	Ditto and under publication.
Sheets Nos. 260 (2nd Edition), 316, 400, 401, 403, 404, 405, 406, and 407 . .	1=1	9	In progress.
Sheets Nos. 313 and 314 .	1=1	2	Boundaries brought up to date.
LOWER BURMA—			
Sheets Nos. 272 S. W./3, 274 N. W./4, N. W./2 (2nd Edition) N. W./3, 274 N. W./4 (2nd Edition), 274 S. W./1, S. W./2, (2nd Edition), S. W./4, 275 N. E./3, 275 N. E./4, 275 S. E./1, S. E./2, S. E./3, S. E./4, 275 N. W./1, N. W./2, N. W./3, N. W./4, 275 S. W./1, S. W./2, S. W./3, S. W./4, 276 N. E./1, (276 N. E./4 and 323 N. W./3) 279 S. W./4, and 280 N. W./2	4=1	26	Completed and published.
NORTH-EASTERN FRONTIER SERIES.			
Sheet No. 15 N.E. (3rd Edition)	1=4	1	Boundaries to date and published.
Sheet No. 15 S.E. (6th Edition)	1=4	1	Brought up to date and published.
Sheet No. 22 S.W. (2nd Edition)	1=4	1	Railways brought up to date.
Sheet No. 22 (6th Edition) .	1=8	1	Completed and published.
Sheet No. 23 N.W. (8th Edition)	1=4	1	Brought up to date and published.
Sheet No. 23 S.W. (8th Edition)	1=4	1	Ditto ditto ditto.
Sheet No. 23 (2nd Edition) .	1=8	1	Hill shading in progress.
SOUTH-EASTERN FRONTIER SERIES.			
Sheet No. 1 N.E. (7th Edition)	1=4	1	In progress.
Sheet No. 1 S.E. (5th Edition)	1=4	1	Ditto.
Sheet No. 1 N.W. (5th Edition)	1=4	1	Ditto.
Sheet No. 1 S.W. (4th Edition)	1=4	1	Additions to date.
Sheet No. 2 N.E. (7th Edition)	1=4	1	In progress.

DRAWING OFFICE, CALCUTTA.

SECTION NO. I—*continued.*

Statement of work—continued.

TITLE.	Scale.	Number of Sheets.	REMARKS.
	In. M.		
STANDARD MAPS—*concld.*			
Sheet No. 2 S.E. (5th Edition)	1=4	1	Additions to date and published.
Sheet No. 2 S.W. (2nd Edition)	1=4	1	Ditto ditto ditto.
Sheet No. 4 N.W. (6th Edition)	1=4	1	Ditto ditto ditto.
Sheet No. 4 (2nd Edition)	1=8	1	In progress.
Sheet No. 5 S.W. (6th Edition)	1=4	1	Additions to date and published.
Sheet No. 5	1=8	1	Completed and under publication.
Sheet No. 6 N.W. (7th Edition)	1=4	1	Additions to date and published.
Sheet No. 6 (2nd Edition)	1=8	1	In progress.
Sheet No. 7 (2nd Edition)	1=8	1	Completed and under publication.
Sheet No. 8 (2nd Edition)	1=8	1	In progress.
ADMINISTRATION REPORT MAPS.			
Upper Burma (2nd Edition)	1=64	1	Additions to date and published.
N.-W. P. and Oudh	1=32	1	Ditto ditto ditto.
Punjab	1=32	1	Ditto ditto ditto.
ASSAM—			
Cachar	1=8	1	Additions to railways.
BENGAL—			
Hill Tippera	1=8	1	Completed and published.
Mymensingh	1=8	1	Ditto ditto.
Noákháli	1=8	1	Ditto ditto.
Purnea	1=8	1	Additions to date.
Ránchi	1=16	1	Completed and published.
Tippera	1=8	1	Additions to date.
CENTRAL PROVINCES—			
Bálághát	1=12	1	Completed and published.
Betúl	1=8	1	Ditto ditto.
Bhandára	1=8	1	Additions to date and ditto.
Hoshangabad	1=12	1	Completed and published.
Jubbulpore	1=8	1	Ditto ditto.
Mandla	1=8	1	Ditto ditto.
Nágpur	1=8	1	Ditto ditto.
Narsinghpur	1=8	1	Ditto ditto.
Nimár (skeleton)	1=8	1	Ditto ditto.
Nimár (with hills)	1=8	1	Ditto ditto.
Raipur	1=20	1	Ditto ditto.
Seoni	1=8	1	Ditto ditto.
HYDERABAD ASSIGNED DISTRICTS—			
Amráoti	1=8	1	Completed and published.
Buldána	1=8	1	Corrections to date.
Ellichpur	1=8	1	Completed and published.
Wún	1=8	1	Ditto ditto.
PUNJAB—			
Dera Gházi Khan	1=8	1	Corrections to date.
Dera Gházi Khan	1=16	1	Completed and published.
Gurgáon	1=8	1	Ditto ditto.

DRAWING OFFICE, CALCUTTA.

SECTION NO. I—*continued.*

Statement of work—continued.

TITLE.	Scale.	Number of Sheets.	REMARKS.
ADMINISTRATION REPORT MAPS—*concld.*	In. M.		
PUNJAB—			
Hoshiárpur	1=8	1	Completed and published.
Kángra	1=12	1	Ditto ditto.
Kohát	1=8	1	Hills brush-shaded for engraving.
Peshawar	1=8	1	Additions to date.
Rawalpindi	1=8	1	Completed and published.
Rohtak	1=8	1	Compilation completed.
Shahpur (skeleton)	1=8	1	Completed and published.
INDEX MAPS.			
For Administration Report	Various.	12	Brought up to date.
Provincial Index File	Various.	24	Ditto.
Index to the traverse operations in Dera Ismáil Khan	1=8	2	Traces made on vellum cloth.
Index to the standard sheets of Lushai Hills	1=16	1	A trace made on vellum cloth.
Index showing survey operations in the Himálayas	1=20	2	Showing 2-inch and 4-inch publications.
Index to the standard sheets of Assam	1=24	1	Brought up to date and published.
Index to the standard sheets of Upper and Lower Burma	1=32	1	In progress.
Index to the standard sheets of Bengal	1=48	1	Showing different surveys.
Index to the standard sheets of Central Provinces	1=48	1	Additions to date.
Index to the standard sheets of Madras	1=48	2	Showing publications.
Index to the standard sheets of North-Western Provinces and Oudh	1=48	1	Additions to date.
Index to the standard sheets of the Punjab	1=48	1	Ditto.
Index to the geographical surveys in Upper Burma	1=128	1	Showing different publications.
Index to the Indian Atlas Sheets	1=256	1	In progress.
TRIANGULATION CHARTS.			
Triangulation Chart of Khási Hills	1=8	1	Completed and published.
Triangulation of Sheet 272 of Lower Burma Survey	1=4	1	Ditto ditto.
Triangulation Chart of Bombay Survey	1=4	2	Published.
Triangulation Chart of No. 20 Party	1=4	9	In progress.
Triangulation Chart of No. 21 Party	1=4	1	Completed and published.
PLANS OF CITES AND CANTONMENTS.			
Plan of Intrenched position of the British Garrison at Lucknow	1=400ft. and 800ft.	2	Completed.
Lucknow, General Plan	1=800ft.	2	Ditto.
Plan of Ahpur Zoological Gardens	1=150ft.	1	Completed and published.
Plan of Umballa Cantonment	1=110ft.	1	A trace made on vellum cloth.
Plan of Calcutta Town	16=1	18	Additions to date.
Plan of Belgaum City and Environs	8=1	1	Ditto ditto.

DRAWING OFFICE, CALCUTTA.

SECTION NO. I—*continued.*

Statement of work—continued.

TITLE.	Scale.	Number of Sheets.	REMARKS.
PLANS OF CITIES AND CANTONMENTS—*contd.*	In. M.		
Plan of Jullundur Cantonment	6=1	1	A trace made on vellum cloth.
Plan of Secunderabad Cantonment and Environs	2=1	1	Ditto ditto.
Map of Simla and Jutogh	6=1	1	Corrections to date.
MISCELLANEOUS MAPS.			
Plan of South Indian Railway	1=1	1	A trace made on vellum cloth.
Plan of Bezwada-Madras Railway	1=1	1	Ditto ditto.
Plan of proposed Santal Railway	1=8	1	Completed.
SPECIAL MAPS.			
Map to illustrate History of Mutiny, 1857	1=6ooft.	1	Prepared.
District Malda—Sheets Nos. 2, 4, 6, and 7	1=1	4	Additions to date.
District Purnea—Sheets Nos. 1, 3, 4, 5, 7, 8, 9, 11, 12, 14, and 15	1=1	11	Ditto ditto.
Postal Atlas of India—Sheets Nos. 103, 112, 113, 114, 120, and 121	1=4	6	In progress.
Map of Rájputána Agency	1=4	1	Completed.
Sketch map of Borakka Range	1=4	1	A trace made on vellum cloth.
Map of Orissa and Burdwan Divisions	1=8	2	Additions to Railways.
Sketch map of countries 10 miles round Saugor, Meerut, Muttra, Nowgong, Allahabad, and Bareilly	1=1	6	Completed.
Route map of Assam	1=16	1	In progress.
Route map of Bengal, Bihar, Orissa, and Chota Nágpur	1=16	2	Ditto. } For reduction by photography to scale 1 inch=32 miles, for Map of Routes in the Bengal Command.
Route map of Central Provinces.	1=16	2	Ditto. }
Route map of North-Western Provinces and Oudh	1=16	2	Ditto. }
Route map of Punjab	1=16	4	Ditto. }
Map of Nepál	1=32	1	Additions and corrections to date.
Map of Assam to illustrate Police Report	1=32	1	Ditto ditto.
WORK DONE FOR OTHER DEPARTMENTS.			
MISCELLANEOUS.			
Map of Gwethe Working Circle.	1=1	65	Completed for the Conservator of Forests, Tenasserim Circle.
Map of Saing Yane Working Circle	1=1	65	In progress, for the Conservator of Forests, Tenasserim Circle.
Sonthál Pargana showing the distribution of the Aryan Languages of the District	1=8	1	Completed and under publication in connection with Linguistic Survey.
Aryan Languages and dialects spoken in East Chota Nágpur.	1=16	1	Ditto ditto ditto.
Illustrating the meeting ground of Bengali, Oriyá, and Bihári.	1=16	1	Ditto ditto ditto.
Illustrating the meeting ground of Bengali, Oriyá, and Bihári.	1=32	1	Ditto ditto ditto.
Languages spoken near the North-West Frontier of India.	1=32	1	Ditto ditto ditto.
Illustrating the area in British India in which Pusto Language is spoken	1=32	1	Ditto ditto ditto.
Illustrating the dialects and sub-dialects of the Bihári Language	1=32	1	Ditto ditto ditto.

DRAWING OFFICE, CALCUTTA.

SECTION NO. I—*continued.*

Statement of work—continued.

TITLE.	Scale.	Number of Sheets.	REMARKS.
WORK DONE FOR OTHER DEPARTMENTS—*contd.*	In. M.		
MISCELLANEOUS—*contd.*			
Illustrating the dialects and sub-dialects of the Bengali Language	1=64	1	Completed and under publication in connection with Linguistic Survey.
Illustrating the area in British India in which Oriyá Language is spoken . . .	1=64	1	Ditto ditto.
India, showing Plague Inspection stations	1=80	1	Prepared.
MAPS, COLOURED, *etc.*			
Maps on various scales . .		1,501	For Surveyor General's Office.
Ditto ditto . .		485	„ Other departments.
TOTAL .		1,986	

DRAWING OFFICE, CALCUTTA.

SECTION No. I—*concluded.*

Statement of work—concluded.

Description of work.	Number of sheets.
MAPS EXAMINED.	
Atlas Sheets	82
General Maps	5
Provincial Maps	24
District Maps	1
Standard Maps	76
Plans of Cities and Cantonments	15
Triangulation Charts	20
Administration Report Maps	83
Index Maps	9
Statistical and Extra Departmental Maps	30
Miscellaneous maps	42
Originals and office copies of various maps with additions and corrections in territorial boundaries and public works	576
Tracing prints prepared for Atlas Reductions	76
Tracings of various maps and of roads, canals, and railways from originals, supplied by Public Works Department	30
Engraved proofs of Atlas Sheets in various stages	164
Engraved proofs of General and Provincial maps including Index charts	53
Engraved proofs of Administration Report maps	40
Litho. proofs of General and Provincial maps including Index charts	28
Litho. proofs of District maps transferred from copper plates	25
Litho. proofs of statistical and extra-departmental maps	6
Photo. proofs of standard sheets and various other maps	304
Colouring of maps for various purposes	638
Projection and examination of graticules and plotting of points	51
TOTAL	2,318

N. B.—In addition to the above, many miscellaneous jobs, such as supply of geographical data to various officials, calculation of areas, computation of graticules for the projection of the sheets of the Indian Atlas, examination of the proof sheets of the "Survey of India Department Notes," and the "General Report on the operations of the Survey of India Department" during 1897-98, as to the correct orthography of geographical names, and various other minor works have been performed by the Examining section.

DRAWING OFFICE, CALCUTTA.

SECTION NO. II.—REVENUE, DRAWING, AND COMPILATION.

Statement showing the work performed during the year 1898-99

TITLE.	Scale.	Number of Sheets.	REMARKS.
	In. M.		
ATLAS OF INDIA.			
Sheet No. 121 . . .	1=4	1	Corrections made to Railway lines.
STANDARD MAPS.			
PUNJAB.			
District Peshawar.			
Sheets Nos. 78 and 79 . .	1=1	2	Proofs sent to press for correction.
Sheet No. 80	1=1	1	Completed up to margin from data of the surrounding countries. Surveyed topographically. Proof sent to local officers for examination.
Sheets Nos. 51 and 52 . .	1=1	2	Completed and sent to press for reproduction to full scale.
Sheets Nos. 105, 106, and 107 .	1=1	3	Completed.
Sheets Nos. 108 and 134 . .	1=1	2	Compilation in progress.
District Hazára.			
Sheet No. 12	1=1	1	Proof passed, press order given.
District Dera Gházi Khan.			
Sheets Nos. 1 to 20. . . .	1=1	20	Additions and corrections made from 4-inch tracings of Settlement officer.
NORTH-WESTERN PROVINCES AND OUDH.			
Districts Meerut and Moradabad.			
Sheet No. 31	1=1	1	Second proof sent to press for correction.
Districts Saháranpur, Muzaffarnagar, and Meerut.			
Sheet No. 15	1=1	1	Completed and published.
Sheets Nos. 6 and 16 . .	1=1	2	Proofs returned to press for correction.
Sheets Nos. 10, 14, 18, and 19 .	...	4	Ditto ditto.
Districts Aligarh, Agra, and Muttra.			
Sheets Nos. 23, 24, 25, 35, 37, and 38.	1=1	6	Ditto ditto.
Districts Jaunpur, Benares, and Mirzápur.			
Sheets Nos. 168, 169, and 171 .	1=1	3	Ditto ditto.
Districts Ghásipur, Benares, and Mirzápur.			
Sheets Nos. 195, 196, and 197 .	1=1	3	Ditto ditto.
Districts Basti, Gorakhpur, and Ghásipur.			
Sheets Nos. 175, 188, 189, 190, 203, 205, 208, and 220 . .	1=1	8	Ditto ditto.
Sheet No. 221 . . .	1=1	1	Completed and published.

DRAWING OFFICE, CALCUTTA.

SECTION NO. II—*continued.*

Statement of work—continued.

TITLE.	Scale.	Number of Sheets.	REMARKS.
STANDARD MAPS—*contd.*	In. M.		
NORTH-WESTERN PROVINCES AND OUDH—*contd.*			
Districts Sahâranpur, Garhwâl, Dehra Dún, and Bijnor.			
Sheet No. 27	1=1	1	New compilation in progress for republication.
Districts Meerut and Muzaffarnagar.			
Sheet No. 31	1=1	1	Proof sheet sent to press for correction.
Portion of Naini Tal (Kumâun Bhâbar) District.			
Sheets Nos. 63 $\frac{S.E.}{3}$, 64 $\frac{N.E.}{1,2,3}$.	1=4	4	Proofs passed and press order given.
Sheets Nos. 46 $\frac{N.E.}{2,4}$, $\frac{S.E.}{2}$, 64 $\frac{S.E.}{1,2,4}$, and 251 $\frac{N.W.}{1,2,3,4}$.	1=4	11	Proofs sent to press for correction.
OUDH.			
Sheets Nos. 134 and 148 . .	1=1	2	Additions and corrections made to boundaries, roads, etc.
BENGAL.			
District Darjeeling.			
Sheets Nos. 269 and 270 . .	1=1	2	Proofs sent to press for correction.
District Muzaffarpur.			
Sheets Nos. 114 and 115 . .	1=1	2	Additions and corrections made to boundaries, roads, etc.
Districts Hooghly and Howrah.			
Sheets Nos. 285 and portions of 208, 263, and portions of 262, 264, and 265 . . .	1=1	4	Proofs sent out to district officers for corrections up to date.
Sheets Nos. 286, 287, and 288 and portion of 289 . .	2=1	7	Corrected for republication.
District Mymensingh.			
Sheets Nos. 347 and 348 . .	1=1	2	Proofs examined and sent to press for correction.
Sheets Nos. 345 and 361 . .	1=1	2	Additions and corrections made to boundaries, roads, etc.
Sheet No. 389	1=1	1	Compiled from old Main Circuit Maps.
District Faridpur.			
Sheets Nos. 2 and 4 (old) . .	1=1	2	Additions and corrections made to boundaries, roads, etc.
District Rájsháhi.			
Sheets Nos. 2, 3, 5, 12, and 13 .	1=1	5	Additions and corrections made to boundaries, roads, etc.

DRAWING OFFICE, CALCUTTA.

SECTION No. II—*continued.*

Statement of work—continued.

TITLE.	Scale. In. M.	Number of Sheets.	REMARKS.
STANDARD MAPS—*contd.*			
ASSAM.			
District Cachar.			
Sheets Nos 68 and 69	1=1	2	Proofs returned to press for final press order.
Sheets Nos. 1 and 3 (old)	1=1	2	Additions and corrections made to boundaries, roads, etc.
CENTRAL PROVINCES.			
District Betúl.			
Sheets Nos. 2, 4, 5, 7, 13, and 36	1=1	6	Additions and corrections made to boundaries, roads, etc., from 16-inch tracings supplied by the local officers.
District Nimár.			
Sheets Nos. 1 to 9	1=1	9	Additions and corrections made to boundaries, roads, etc., from 16-inch tracings supplied by the local officers.
BOMBAY.			
Sheets Nos. 164, 192, 350, and 351	1=1	4	Proofs passed and press order given.
Sheets Nos. 183, 195, 201, 203, 204, 206, 231, 232, and 328	1=1	9	Proofs sent to press for correction.
Sheets Nos. 206 and 240	1=1	2	Additions and corrections to boundaries, etc.
District Thána.			
Sheets Nos. 133 S.E. 1, 2, 3, 4, 134 N.E. 1, 2, 3, 4, and S.E. 1, 2, 3, 4	4=1	12	Proofs sent to press for correction.
LOWER BURMA.			
Districts Pegu, Tharrawaddy, and Toungoo.			
Sheets Nos. 274, 275, 276, 322, 323, 324, and 325 (in 4 sections each)	2=1	28	Fair maps received from the executive officers, examined cursorily and reported.
Districts Pegu and Thatón.			
Sheets Nos. 326, 327, 372, and 373 (in 4 sections each)	2=1	16	Ditto ditto.
Sheets Nos. 179, 277, 280, 232, 421, and 422	1=1	6	Second proof returned to press for correction.
Sheets Nos. 140 and 278	2=1	2	Fair maps corrected and sent to press for further proofs.
District Tavoy.			
Sheets Nos. 486, 487, and 488	1=1	3	Proofs sent out to district officers for approval and reference.
Sheet No. 489	2=1	4	Fair maps examined.
Sheets Nos. 557 S.W. and 558 N.W.	2=1	2	Compiled from Cadastral maps and examined.
UPPER BURMA.			
Southern Shan States.			
Sheet No. 404	1=1	1	Finished hill shading for No. 41 Party.
District Minbú.			
Sheets Nos. 127 and 174	1=1	2	First proof returned to press for corrections.
Sheets Nos. 128, 129, and 175	1=1	3	Second proof sent to press for correction.

DRAWING OFFICE, CALCUTTA.

SECTION NO. II—*continued.*

Statement of work—continued.

TITLE.	Scale.	Number of Sheets.	REMARKS.
STANDARD SHEETS -*contd.*	In. M.		
UPPER BURMA—*contd.*			
District Kyaukse.			
Sheets Nos. 263 and 264 . .	2=1	6	Fair maps corrected from district officer's maps and sent to press for republication.
District Meiktila.			
Sheets Nos. 263 $\frac{N.W.}{S.W.}$, 264 $\frac{N.W.}{S.W.}$, 265 $\frac{N.W.}{S.W.}$, 216 S. W., S. E., 217 $\frac{N.W.N.E.}{S.W.S.E.}$, 218 $\frac{N.W.N.E.}{S.W.S.E.}$, and 219 N. W., N. E. . .	2=1	18	Fair maps received from the Executive Officer, examined and blue print reductions sent to o/c No. 10 or 11 Party.
District Yamèthin.			
Sheets Nos. 269, 270, and 271 .	2=1	12	Ditto ditto. and proofs sent to district officer for reference.
Sheets Nos. 218 S.E., 219 $\frac{N.W.N.E.}{S.W.S.E.}$, 220 $\frac{N.E.}{S.E.}$, 221 N.E., 266 $\frac{N.W.}{S.W.S.E.}$, and 267 $\frac{N.W.}{S.W.}$ . . .	2=1	13	Fair maps received from the Executive Officer, examined and 1 inch blue prints supplied to the o/c No. 10 or 11 Party.
Sheets Nos 267 $\frac{N.W.}{2\cdot4}$, $\frac{N.E.}{1\cdot3}$, $\frac{S.E.}{1\cdot3\cdot4}$, and 268 $\frac{N.E.}{1\cdot2\cdot3\cdot4}$.	4=1	11	Ditto. ditto.
PARGANA MAPS.			
District Birbhúm.			
Sheets Nos. 1, 9, and 10 . .	1=1	3	Additions and corrections made to boundaries, roads, &c.
District Champáran.			
Sheets Nos. 7 and 11 . .	1=1	2	Ditto ditto.
District Cuttack.			
Sheets Nos. 7 and 8 . .	1=1	2	Ditto ditto.
District Dacca.			
Main Circuit No. 12 . .	1=1	1	Printed map touched up, corrected, and sent to press. Proof examined and returned to press for corrections.
Main Nos. 1, 2, 3, 4, 5, 6, 7, and 8	1=1	8	Additions and corrections made to boundaries, roads, etc.
District Monghyr.			
Sheet No. 8	1=1	1	Printed map touched up. Corrected and sent to press for reproduction. Proofs passed and press order given.
District Mymensingh.			
Main Circuits Nos. 3, 8, 9, 15, and 16	1=1	5	Additions and corrections made to boundaries, roads, etc.
Main Circuit No. 20 . .	1=1	1	Printed copy corrected and touched up for press.
District Cooch Behar.			
Sheets Nos. 2 and 8 . . .	1=1	2	Additions and corrections made to boundaries, roads, etc.

DRAWING OFFICE, CALCUTTA.

SECTION No. II—*continued.*

Statement of work—continued.

TITLE.	Scale.	Number of Sheets.	REMARKS.
PARGANA MAPS—*contd.*	In. M.		
District Nadia.			
Sheet No. 5	1=1	1	Additions and corrections made to boundaries, roads, etc.
District Rájsháhi.			
Main Circuits Nos. 1, 6, and 8 .	1=1	3	Additions and corrections made to boundaries, roads, etc.
District Sylhet.			
Main Circuits Nos. 6, 8, 9, and 10	1=1	4	Additions and corrections made to boundaries, roads, etc.
District Tippera.			
Main Circuits Nos. 1, 2, 5, 6, 8, 9, and 12	1=1	7	Additions and corrections made to boundaries, roads, etc.
District 24-Parganas.			
Sheets Nos. 1 and 2 . . .	1=1	2	Proofs examined and returned to press for corrections.
Panchánnagrám Survey.			
Grand division 2, Sub-division 3	1 in.=99 ft.	1	Printed maps touched up, corrected, and sent to press for reproduction. Proofs passed, press order given.
Ditto ditto O		1	
Ditto ditto N. Secn. 2		1	
CENTRAL PROVINCES.			
District Bhandára.			
Sheets Nos. 2, 3, 4, 5, 7, 8, and 20	1=1	7	Additions and corrections made to boundaries, roads, etc., from 16-inch tracings supplied by local officers.
District Maps.			
PUNJAB.			
Gujránwála	1=2	2	Additions and corrections made to boundaries, roads, etc.
Hasára.—(Skeleton map without numbers, with village boundaries) . .	1=4	1	Proofs passed, press order given.
Umballa.—(Skeleton with Nos.) .	1=2	2	Compiled from 1-inch sheets and drawn for reduction to scale 1-inch=4 miles. Proofs sent to district officer for examination and approval.
CENTRAL PROVINCES.			
Nágpur and Wardha . .	1=2	2	Additions and corrections made to boundaries, roads, etc.
Ditto	1=4	1	Additions and corrections made to boundaries, roads, etc.
BENGAL.			
Palámau	1=4	1	Proofs passed, press order given.
PLANS OF CITIES AND CANTONMENTS.			
Bareilly	12=1	21	Typed and drawing in progress for reduction to half scale.
Cawnpore	12=1	9	Proofs corrected and sent to press for further proof.
Allahabad	6=1	6	Proofs corrected and sent to prers for further proof.

DRAWING OFFICE, CALCUTTA.

SECTION NO. II—*continued.*

Statement of work—continued.

TITLE.	Scale.	Number of Sheets.	REMARKS.
PLANS OF CITIES AND CANTONMENTS—*contd.*	In. M.		
Calcutta	3=1	1	Press order given.
Calcutta and Suburbs with added area	6=1	2	Re-compiled from old data brought up to date with reference Nos. to roads, streets, and lanes, etc., explained in columns of alphabetical lists.
Murree (Sanitarium)	10=1	6	Additions and corrections made to boundaries, etc.
Campbellpur	6=1	1	Ditto ditto.
Ránikhet	6=1	1	Ditto ditto.
Lansdowne	12=1	1	Ditto ditto.
Ghoradhaka (Hutted Camp)	12=1	1	Ditto ditto.
Barágali (Ditto)	12=1	1	Ditto ditto.
Kálabágh (Ditto)	12=1	1	Ditto ditto.
Thoba (Ditto)	12=1	1	Ditto ditto.
Khyragali (Ditto)	12=1	1	Ditto ditto.
Changlagali (Ditto)	12=1	1	Ditto ditto.
Nasírabad (District Ajmer)	6=1	1	Ditto ditto.
Bareilly	16=1	21	Ditto ditto.
Sítabáldi Fort	10=1	1	Ditto ditto.
Hazára	10=1	1	Ditto ditto.
Gharail Cantonment	10=1	1	Ditto ditto.
Dharamsála „	10=1	1	Ditto ditto.
Moulmein Town	1 in.=50 ft.	51 to 69	Proofs passed and press order given.
Rangoon „	1 in.=50 ft.	51	Ditto ditto.
Ditto „	1 in.=50 ft.	140	Originals sent to press for reproduction and proofs passed, press order given.
Ditto „	1 in.=100 ft.	154	Originals sent to press for reproduction.
Basti Civil Station	8=1	1	Compiled from Cadastral plans, proofs passed, press order given.
MISCELLANEOUS.			
Naiháti Municipality	4=1	2	Compiled from data supplied by the Municipal authorities. Proofs sent to local officers.
Narhan Estate	1=4	2	Proofs passed and press order given.
Handkerchief Map of 10 miles round Calcutta for Officer Commanding Fort William	1=1	1	Compiled, proofs passed, and press order given.
Ditto ditto	2=1	2	Compiled, proofs returned to press for corrections.
Pargana Talla Des (District Naini Tal—Bhábar)	1=2	1	Proofs passed, press order given.
Index Maps.			
For Administration Report	various	2	Drawn and sent to press.
Ditto ditto	„	14	Corrected up to 1899 and sent to press.
Tracing on cloth.			
Tracings of sheets	„	79	These tracings, sheets, and plans have been prepared for Government officials and other departments.
Sheets congregated	4=1	3	
Plans	various.	21	
Maps coloured.		46	For office use.
Ditto.		23,465	Colouring examined for stock in Map Record and Issue Office.

DRAWING OFFICE, CALCUTTA.

SECTION No. 11—*concluded.*

Statement of work—concluded.

DESCRIPTION OF WORK.	REMARKS.
Computations Examined.	
District Magwe, Seasons 1891-94, (3 seasons)	
„ Sylhet „ 1890-93, (3 seasons)	
Traverse data, etc., supplied.	
Of Nepál boundary along Sárda River with Synopsis of boundary and Bearing Pillars of the Survey of 1893 (25 pages).	To Superintendent, Land Records Surveys, North-Western Provinces and Oudh.
Of Pargana Jalesar along District Etah	To O. C., Nos. 2 and 8 Parties.
„ Sylhet along Hill Tippera with Co-ordinates from Origin of Survey.	To O. C., No. 6 Party.
„ Forest blocks, district Hoshangabad (291 pages)	To Forest Divisional Officer, Hoshangabad.
„ district Naini Tal along district Pilibhít	To Superintendent, Land Records Surveys, North-Western Provinces and Oudh.
„ „ Chhindwára along Jagirs (6 pages)	To Superintendent, Forest Surveys, Ditto ditto.
„ Sconi Forests (8 pages)	To O. C., No. 20 Party.
„ villages along Ye river, district Amherst (9 pages).	Ditto ditto.
„ Pegu villages (20 pages)	Ditto ditto.
„ Thatón villages and Forests (50 pages)	To Collector.
„ Backergunge villages (24 pages)	To Deputy Commissioner.
„ districts Amherst and Thatón (349 pages)	To Settlement Officer.
„ district Pegu (69 pages)	To Deputy Commissioner.
„ „ Mandalay (45 pages)	Ditto ditto.
„ „ Henzada (28 pages)	Ditto ditto.
„ „ Amherst, along Forest boundary (12 pages)	To public officers.
Village Traverses (49 pages)	To Settlement Officer.
Field Area statements of district Puri (23 pages)	To Deputy Commissioner.
„ „ „ „ Minbu (225 pages)	Ditto ditto.
„ „ „ „ Akyab (219 pages)	To Director, Land Records.
„ „ „ „ Mergui (4 pages)	To Settlement Officer.
„ „ „ „ Magwe (6 pages)	To Deputy Commissioner.
„ „ „ „ Prome (5 pages)	To Settlement Officer.
Tables of Co-ordinates of district Hanthawaddy (297 pages).	To Deputy Commissioner.
Tables of Co-ordinates of district Henzada (650 pages)	
Miscellaneous.	
Calculated latitudes and longitudes of certain Nepál Boundary pillars along Oudh; also Origin and certain stations of district Azamgarh. Calculated areas by tálukas of the Nizam's dominions and of Sheet 201 Bombay; also by *parganas* of sheets 307 and 347 of Central India Agency; of districts 24-Parganas and Ránchi in Bengal; of districts Gurdáspur, Jhelum, and Ráwalpindi in the Punjab; of the Sámbhar Lake in Rájputána, and of Banaili Raj estates in sheets 1, 3, 4, 8, 9, 10, 11, and 17, Bhágalpur. Revised the areas of districts Cuttack, Balasore, and Puri. Calculated and prepared two tables for converting acres and decimals into *bighas, cottahs,* and *chittacks* and *vice versá,* for the Collector of Dacca. Computed 4 traverse circuits and 11 sub-circuits, and plotted the same for preparation of a congregated map on a radius of 10 miles round Calcutta City for Government, Bengal; also of a group of 13 villages for the Collector of Pabna. Plotted traverse stations of one line of bordering villages of district Midnapore transferred to district Hooghly. Prepared a statement showing areas by Imperial Traverse Surveys, by Patwári Cadastral Surveys and by Forest Surveys of the districts in Central Provinces, from commencement of operations, for Deputy Surveyor-General. Prepared Summary of Outturn and Cost-rate statements, etc., for General Report. Examined Annual Statements received from executives.	

DRAWING OFFICE, CALCUTTA.

SECTION No. III.—CADASTRAL.

State of publication of Cadastral Maps on the 30th September 1899.

DISTRICTS.	NUMBER OF SHEETS.							REMARKS.
	MAPS RECEIVED.			MAPS PUBLISHED.				
	Up to 30th September 1898.	Added during past 12 months.	Total up to 30th September 1899.	Up to 30th September 1898.	By Surveyor General's Office during past 12 months.	Total to 30th September 1899.	Remaining to be published.	
North-West Provinces.								
Agra	2,942	...	2,942	2,942	...	2,942	...	
Azamgarh	930	...	930	930	...	930	...	
Ballia	1,601	...	1,601	1,601	...	1,601	...	
Bánda	3,317	...	3,317	3,317	...	3,317	...	
Basti	5,571	...	5,571	5,571	...	5,571	...	
Benares	2,052	...	2,052	2,052	...	2,052	...	
Bijnor	31	...	31	31	...	31	...	
Dehra Dún	701	...	701	701	...	701	...	
Fyzabad	14	...	14	14	...	14	...	
Garhwál	9,100	...	9,100	8,467	633	9,100	...	
Gházipur	4,021	...	4,021	4,021	...	4,021	...	
Gorakhpur	8,615	...	8,615	8,615	...	8,615	...	
Hamírpur	2,926	...	2,926	2,926	...	2,926	...	
Jaunpur	3,583	...	3,583	3,583	...	3,583	...	
Jhánsi	1,661	...	1,661	1,661	...	1,661	...	
Kumáun (Bhábar)	332	...	332	332	...	332	...	
Moradabad and Tarái	4,023	...	4,023	4,023	...	4,023	...	
Muttra	1,658	..	1,658	1,658	...	1,658	...	
Mirzápur	3,794	...	3,794	3,794	...	3,794	...	
Rámpur State	1,356	..	1,356	1,356	...	1,356	...	
Tarái	862	...	862	862	...	862	...	
TOTAL	59,090	...	59,090	58,457	633	59,090	...	
Burma.								
Akyab	2,785	...	2,785	2,785	...	2,785	...	
Amherst	3,664	...	3,664	3,664	...	3,664	...	
Bassein	3,437	...	3,437	3,437	...	3,437	...	
Hanthawaddy and Pegu	4,601	...	4,601	4,601	...	4,601	...	
Henzada	1,391	...	1,391	1,391	...	1,391	...	
Katha	284	1,322	1,606(a)	235	922	1,157	449	(a) These figures are liable to alteration until publication has been completed.
Kyaukse	814	...	814	814	...	814	...	
Magwe	1,024	6	1,030	38	992	1,030	...	
Mandalay	792	...	792	792	...	792	...	
Meiktila	1,874	2	1,876	1,874	2	1,876	...	
Meiktila Town	...	19	19	...	19	19	...	
Mergui	1,071	...	1,071	1,071	...	1,071	...	
Minbu	1,447	...	1,447	1,447	...	1,447	...	
Pegu	519	71	590	135	455	590	...	
Prome	847	...	847	847	...	847	...	
Rangoon Town and Index	20	...	20	20	...	20	...	
Saigaing	2,286	1	2,287(a)	1,797	3	1,800	487	
Shwebo	...	2,796	2,796(a)	...	1,038	1,038	1,758	
Tavoy	763	...	763	763	...	763	...	
Tharrawaddy	1,363	...	1,363	1,363	...	1,363	...	
Thatón	1,200	...	1,200	1,200	...	1,200(b)	...	(b) Exclusive of 5 sheets reprinted.
Thôngwa	3,749	...	3,749	3,749	...	3,749	...	
TOTAL	33,931	4,217	38,148	32,023	3,431	35,454	2,694	
Bengal and Orissa.								
Backergunge	261	...	261	261	...	261	...	
Cuttack Town	86	...	86	86	...	86	...	
Gaya (Tikári Ward's Estate)	...	700	700(c)	...	289	289(c)	411	(c) Published by order of the Board of Revenue, Lower Provinces.
Muzaffarpur	1	...	1	1	...	1	...	
Patna and Gaya	3,054	...	3,054	3,054	...	3,054	...	
Puri (Khurda Estate)	4,565	...	4,565	4,565	...	4,565	...	
Sháhabad	4,924	...	4,924	4,924	...	4,924	...	
TOTAL	12,891	700	13,591	12,891	289	13,180	411	
Assam.								
Cachar	495	685	1,180(a)	431	256	687	493	
Darrang	1,074	...	1,074	1,074	...	1,074(d)	...	(d) Exclusive of 29 sheets reprinted.
Kámrúp	2,218	...	2,218	2,210	...	2,210	8(g)	(e) Exclusive of 1 sheet reprinted.
Lakhimpur	346	...	346	346	...	346(e)	...	
Nowgong	1,277	...	1,277	1,277	...	1,277	...	
Sibságar	2,050	...	2,050	2,042	...	2,042	8(g)	
Sylhet	213	...	213	168	...	168	45(g)	
Sylhet (Jaintia)	651	..	651	651	...	651(f)	...	(f) Index to villages of these has been printed.
TOTAL	8,324	685	9,009	8,199	256	8,455	554	(g) These are not to be printed.
Central Provinces.								
Raipur	43	...	43	43	...	43	...	
TOTAL	43	...	43	43	...	43	...	
GRAND TOTAL	114,279	5,602	119,881	111,613	4,609	116,222	3,659	

DRAWING OFFICE, CALCUTTA—*continued.*

SECTION No. III.—CADASTRAL—*continued.*

Abstract of work performed during 1898-99.

PROVINCES.	NUMBER OF SHEETS.				REMARKS.
	Examined and rendered suitable for Photo-zinco-graphy.	Traced and examined for zinco-graphy.	Proof sheets examined previous to press order.	Coloured and subsequently examined.	
North-West Provinces	476	...	633	...	32 inches & 16 inches=1 mile.
Burma	3,703	982	3,435	...	16"=1 mile.
Bengal	241	72	300	...	16"=1 mile.
Assam	399	69	258	...	16"=1 mile.
TOTAL	4,819	1,123	4,626	...	

DRAWING OFFICE, CALCUTTA.

SECTION NO. IV.—BENGAL PROVINCIAL.

Statement showing progress of 2-inch mapping during 1898-99.

PROVINCES.	Total number of sheets.	Graticules projected.	Stations plotted.	Details reduced by pantagraph and transferred to 2-inch sheets.	Number of villages, streams, etc., typed.	Outlining completed.	Feinotes, margins, etc., completed.	Examined.	Finally examined.	Sent to Photograph Office for reduction to 1-inch scale.	Proofs examined.	Final press order given.	REMARKS.
Orissa.													
Previously reported	124	124	124	124	124	118	114	114	114	88	88	12	
Completed during the year including Khurda	...	...	...	...	...	6	10	10	...	16	16	...	
TOTAL	124	124	124	124	124	124	124	124	114	104	104	12	
Bihar.													
Previously reported	124	118	118	104	92	68	40	56	16	16	...	...	
Completed during the year	...	6	...	...	8	24	...	...	32	32	16	...	
TOTAL	124	124	118	104	100	92	40	56	48	48	16	...	
Chittagong.													
Previously reported	...	...	...	...	...	...	...	...	...	...	...	...	
Completed during the year	60	60	60	48	...	16	...	...	...	...	...	...	
TOTAL	60	60	60	48	...	16	...	...	...	...	...	...	

ENGRAVING OFFICE, CALCUTTA.

Statement showing the work performed during the year 1899-99.

Title of Map.	Number of plates.	Outline, square inches.	Number of letters cut.	Hills, square inches.	Remarks.
Atlas of India.					
Scale, 1 inch=4 miles.					
Quarter sheets, new, completed .	8	88	7,250	127	
Ditto do. in progress .	64	1,555	104,511	253	
Additions and corrections to published quarter sheets . .	50	287	55,290	64	
Ditto ditto full sheets .	15	322	35,321	212	
New plates projected, etc. (Atlas sheets)	29	197	4,467	...	
General Maps.					
On various scales . . .	15	414	8,698	109	
Provincial Maps.					
On scales, 1 inch=16 and 32 miles	22	179	60,534	244	
District Maps.					
On various scales for Administration Reports	28	545	25,689	185	
Index Maps	6	81	1,904	...	
Charts	5	91	3,971	...	
Miscellaneous subjects . .	64	...	40,953	...	
Total .	306	3,759	348,548	1,194	

Copper-plate Printing.

Impressions taken	17,514
Proofs pulled	581
Transfers pulled	529
Total .	18,624

Steel Facing.

Double elephant plates, steel faced	25
Ditto " " removed	32
Quarter sheet " " faced	77
Ditto " " removed	70
Miscellaneous " " faced	19
Ditto " " removed	13
Total .	236

PHOTOGRAPHIC AND LITHOGRAPHIC OFFICE, CALCUTTA.

Extract from the Narrative Report of MR. T. A. POPE, *Assistant Surveyor General, season 1898-99.*

Outturn.—The past year has been one of much activity in the Photographic and Lithographic Office, and the outturn of printed maps and plans has increased very considerably. The increase is principally owing to a much heavier demand than usual made upon the Office by other departments and Government officials, while the amount of work done for the Survey Department has also been larger during the year, owing to an increase in the number of cadastral maps printed. The details of the work performed in each Section are given in full in the statements which appear in the Appendix.

Original Subjects.—During the year, the number of original subjects of all kinds received for reproduction and put in hand was 6,873, or 509 more than in the previous year. The increase is in the number of extra-departmental subjects undertaken, which amounted to 1,524, or 422 in excess of last year. The number of departmental maps other than cadastral sheets shows a falling off during the year, but the number of cadastral sheets is somewhat larger.

Of the 6,873 subjects dealt with during the year, 540 were lithographed, of which 53 were departmental maps and 487 were extra-departmental subjects. The remaining 6,333 subjects were either reproduced by the various photographic processes or zincographed, and include 601 departmental maps, 4,695 cadastral maps, and 1,037 extra-departmental subjects. The actual number of subjects received during the year, including those not as yet taken up for reproduction, was 6,932 (598 departmental, 4,821 cadastral, and 1,513 extra-departmental). The number completed, and of which the required number of copies was supplied during the year, was 6,470 (438 departmental, 4,699 cadastral, and 1,333 extra-departmental).

Lithographic Drawing Section.—During the year, the time of several of the senior draftsmen was largely occupied with long and important pieces of work, such as the preparation of the six sheets of the new railway and canal map of India, the new edition of the military map of India, and other large maps, and consequently the number of new subjects drawn on stone or transfer paper is somewhat less than usual, *viz.*, 483, of which 68 were departmental and 415 extra-departmental, as against 650 (54 departmental and 596 extra-departmental) last year. The draftsmen were kept fully employed throughout the year and the younger hands have made very satisfactory progress. The younger draftsmen are now all being trained to work on stone, zinc and transfer paper, instead of, as formerly, having one set of men trained for each class of work. This will be advantageous at times when there is no work to be done on transfer paper, as the men can then be employed on either stone or zinc. The Section is directly supervised by Mr. Fogarty, Head Assistant, Litho. Branch, but in the course of time I hope to be able to relieve him of the duty of constantly supervising the draftsmen while at work by placing a young Assistant, who is now in course of training, in subordinate charge. The management of a staff of 36 draftsmen is in itself sufficiently heavy to occupy all the time of one man; and with this relief the Head Assistant will be able to give more close supervision to the lithographic transferring, proving, and printing, for all of which he is responsible.

Lithographic Printing Section.—Sergeant Vandyke, R.E., who is in charge of this Section, proceeded to England on a year's furlough in February 1899, and the duties have since been carried on by Mr. Deas. The number of subjects printed from stone was 540, or 16 more than last year. Of these 53 were departmental and 487 extra-departmental, as against 58 departmental and 466 extra-departmental last year. The number of pulls from stone was 607,450, as against 547,497, and the total number of copies printed was 529,360, as against 402,906—a very substantial increase.

The new double demy litho. and zinc-printing machine, the arrival of which was reported last year, has worked very satisfactorily. Without it it would have been quite impossible to have turned out the very large amount of printing work that has passed through the Office this year. On Mr. Deas giving up the charge of No. 1 machine to relieve Sergeant Vandyke, Mr. Ravenscroft was placed in charge of it, and Mr. Aratoon, a young apprentice who has been in training for this work for some months, was given the new machine, No. 3, and considering his youth and inexperience he has managed it extremely well. No. 2 machine has been run throughout the year by one of the native printers who has had several years training; and the small litho. machine, No. 4, was made over to another native printer who had previously assisted Mr. Deas in running No. 1. That three of the lithographic machines should have been managed for the past seven months by a young apprentice of less than a year's standing and two native printers trained in the Office, without any hitch, and with only occasional assistance from the Foreman Litho. Printer, is very creditable to the men concerned. The small litho. machine, No. 4, was under repair for about a month owing to the accidental fracture of the spring in the cylinder. It is not probable that this machine, which has been many years in use, will last much longer.

Zinc plates are now used instead of paper for pulling all impressions for making offsets, thus doing away with any chance of shrinking or stretching, with the result that much less difficulty is experienced in registering colour stones and plates. Another slight im-

[redacted]t, recently introduced, consists in the use of pumice stone powder to remove all [redacted] of offset before transferring copper-plate rulings in making up administration report [redacted] other similar maps. This saves much time, as the tints now roll up clean and no trace of offset appears.

Zinc-Printing Section (Normal).—This Section remained under the charge of Mr. E. A. LeFranc throughout the year. The number of zinc plates printed was 927, or 10 more than last year, and of these 301 were departmental subjects and 626 extra-departmental, as against 339 departmental and 578 extra-departmental last year. The number of pulls was 229,458 (departmental 93,239, extra-departmental 136,219), and of complete copies 299,463 (departmental 68,104, extra-departmental 231,359). Last year the number of pulls was 194,539 (departmental 65,537, extra-departmental 128,998) and of complete copies 198,578 (departmental 68,427, extra-departmental 130,151). From these figures it will be seen that the work of the Section shows a very large increase for the year under report, which is entirely in work done for other departments. The transferring and proving of the sheets of the Rangoon town map occupied considerable time, and during the latter part of the year one hand press and the services of an Assistant Zincographer had to be utilized for this work alone. The standard sheets of trans-frontier surveys, with hills in brown, which have latterly been reproduced in considerable numbers and require great care in transferring and printing, also occupied a large share of Mr. LeFranc's time and attention during the year.

Zinc-Printing Section (Cadastral).—Mr. J. B. MacKenzie continued in charge of this Section during the year. The number of cadastral sheets received for reproduction shows a slight increase, amounting to 4,695, as against 4,477 last year. These were nearly all sheets of the Burma and Assam surveys, of which a much larger number of copies is required than of the North-West Provinces sheets, and consequently the number of copies printed during the year is very considerably larger than that of last year, when the sheets of the North-West Provinces were principally dealt with. The number of plates printed off was 4,621, the number of pulls being 145,312 and of copies of complete villages 136,630, as against 103,530 pulls and 94,328 copies of complete villages, printed from 4,649 plates, last year.

Type-Printing Section.—As measured by the number of copies printed, the work of this Section shows a slight falling off from the large outturn recorded last year, owing to the requirements of the department for professional forms having been well supplied in advance in the previous year. The number of pages or items set up is, however, somewhat larger, *viz.*, 13,932, as against 13,819 last year, as is also the number of pulls, which was 1,277,949, as against 1,176,837. The total number of copies printed was 684,039, as against 700,756 last year.

The type-printing machine mentioned in last year's Report, as having been indented for, was duly received and was in course of erection at the close of the year. After some correspondence with the Store Department of the India Office, it was decided not to obtain a stop-cylinder machine by Messrs. Hoe and Sons, as this proved to be a much more expensive type of machine than we required, and a "Royal Wharfedale" machine, by Messrs. Payne and Sons, was substituted for it. So far as can be judged at present it seems likely to answer, but a further report will be made on this point next year. The "Washington" hand type press was also received and fitted up, and has been of great assistance in proving half-tone blocks, for which purpose we had no suitable press before.

The working of this Section is much handicapped for want of proper accommodation for the compositors, and storage for type materials and for the large and constantly increasing number of professional forms which have to be kept in type. As explained below, it will also be necessary to find other space for the duftries and despatching clerks, and the best arrangement seems to be to locate these in the two small rooms now occupied by the compositors, and to build a new room for the Head Type Printer and his staff over the stone godown at the rear of the office, and I trust that this may receive sanction and be put in hand next year.

Negative Section.—The number of negatives taken during the year was 5,567, or 325 more than last year. These include 110 transparencies taken in the Heliogravure Section. The number of negatives of departmental subjects was 846, of cadastral maps 3,621, and of extra-departmental subjects 1,100.

As it was found that by obtaining our stock of photographic glass from England in one large consignment once every year, portions of it which were not brought into use until after the rainy season were liable to become so corroded by damp as to be useless for negative work, arrangements were made with the Director General of Stores, India Office, to receive it in four quarterly instalments, so that the whole of the newly arrived glass could be unpacked and given out for use during the quarter. This system has been in force during the past year and has worked well. The Section remained under the charge of Mr. H. Haward, Head Assistant, Photo. Branch. No changes of any importance were found necessary in the processes employed.

Photo-Transfer Printing Section.—There were 5,711 photo-transfer prints made during the year, or 550 more than in the year previous. Of these 913 were departmental subjects, 3,645 cadastral maps, and 1,153 extra-departmental subjects. The Section was in charge of Mr. R. George throughout the year, and there is nothing special to record in connection with its working.

Silver-printing Section.—Somewhat less work was done in this Section. The number of blue or cyanotype prints made, fell from 2,174 in the previous year to [illegible] in the year under report, and of silver-prints from 283 to 120. The demand for the latter depends upon outside requirements and varies considerably. Prints from negatives can now be obtained so quickly and cheaply by the half-tone block process that silver-prints are rarely made except when the number required is very small. When, as sometimes happens, there is no work for the men employed in this Section (which only consists of one European Assistant, a native photographer, and one cooly) they are employed in the Negative Section where work can always be found for them. Mr. C. J. Meade continued in charge throughout the year.

Heliogravure Section.—I have again to report a large increase of work in this Section. The number of photogravure plates etched was 128, or 27 more than last year, and the number of prints made amounted to 86,514, as against 73,801 last year. This outturn was yielded by the same number of presses (one copperplate printing machine and three hand presses) as has been in use for some years past, the new "D" copperplate printing machine not having been received in time to be worked during the year. This has now been set up and it will enable the Section to deal more expeditiously with the constantly increasing amount of printing work required. It has not been found necessary to introduce any changes in the method of working the photogravure process. The frontispiece to this Report, a portrait of Major-General C. Strahan, R.E., late Surveyor General of India, is a specimen of the work turned out by it during the year. Another specimen, representing one of the trigonometrical stations of the Manipur Longitudinal Series, will be found at p. 82.

Seventy-eight half-tone blocks were made by the "Enamelline" process, and the number of prints made from them was 12,100, as against 8,100 prints from 82 blocks last year.

Only eight hand-engraved plates were electrotyped during the year, or five less than last year, but in addition to this, ten hand-engraved plates were prepared for correction by the process of electro-deposition described in last year's Report. This process is proving itself very useful, as in cases in which very heavy corrections are required to be made, the necessity for preparing electrotyped duplicates is obviated. It has been worked with fair success throughout the year, but is found to require the utmost care and the most absolute chemical cleanliness at every stage. Consequently failures have occasionally resulted, but in such cases the original plate is in no way injured, the work having only to be done again. Mr. Turner has been in charge of the Section throughout the year. The constantly increasing quantity of routine work that passes through his hands has prevented him from giving as much time as he would wish to experimental work in new directions.

Machinery.—With the exception of the accident to the spring of the small litho. machine mentioned above, all the printing machinery worked well throughout the year. The new type machine, the "Washington" hand type press, the copperplate printing machine, and the two litho. presses ordered last year to replace old and worn out plant, were all received, but only the hand type press, the copperplate machine, and one of the litho. presses could be set up and put in running order before the close of the year. These have proved valuable additions to our printing power, and the type machine and litho. press (which latter can be adapted to either steam or hand power) seem also to be likely to suit us. It is hoped that they will be set to work very shortly, but it has been found necessary to lengthen the shafting somewhat in order to find room for them, and this has taken longer than I expected.

The space at present available for the printing and other machinery is, owing to the recent additions that have been made, somewhat too restricted either for safety or convenience. I propose therefore to remove the duftries from the space they now occupy at one end of the Press Room, and to extend the main shafting to the end of the room, which will enable the machines to be placed in positions slightly further apart, and give sufficient space for the workmen to pass between them, and for inking tables, roller stands, etc. Before this can be done it will be necessary to provide other accommodation for the duftries and despatchers, and the best plan will be to give them the two rooms now occupied by the Type-printing Section, which, as I have already mentioned, is very much cramped for want of space. This Section should have entirely new accommodation provided for it by the erection of an upper storey to the stone godown. The Executive Engineer, Second Calcutta Division, has at my request examined the stone godown and informs me that this can easily be done, at no very great expense. I have, therefore, applied in the usual manner for the inclusion of this very necessary building, and of the extension of the shafting, among the items of new work to be carried out by the Public Works Department during the next financial year.

The new boiler by Messrs. Marshall, Sons & Co. was duly received and erected, and was in working order at the close of the year, but had not then been passed by the Boiler Inspector.

Reorganisation of the office.—The scheme for the reorganisation of the Office establishment received the sanction of the Secretary of State and came in force on the 1st December 1898. It provides for the amalgamation of the establishment of this Office with the small photo.-zinco. staff of the Trigonometrical Branch Office at Dehra Dún; for the grading of the entire establishment in one list for the purpose of promotion, and

abolition of nearly all the old posts on progressive salaries. The only posts remaining on progressive pay are the four posts which comprise the First Division, which will, as a rule, be recruited from England, and four apprentice posts in the Second Division. The Second Division comprises all the other European and Eurasian assistants and one or two selected natives ; the Third Division contains all the draftsmen and assistant photographers, and the Fourth Division all the compositors, printers, and pressmen. Promotion will not be made from one division to another, except in cases of specially deserving men ; but the scale of pay in each division has been so regulated that every man may look forward to receiving in due course an amount of promotion commensurate with his standing in the Office, and with the duties he is called upon to perform. It is satisfactory to record that after ten months' experience of its working, the new scheme has proved to entirely fulfil the objects for which it was introduced.

PHOTO[illegible]

Abstract of Departmen[illegible]

Specification.	Sheets or subjects.	Negatives and transparencies.	Photo.-zincographic and Lithographic Printing.							
			Photo-transfer prints.	Zinc plates transferred.	Zinc plates printed.	Stones.	Pulls.	Number of copies.		
								Coloured.	Uncoloured.	Total.
Departmental Maps, Plans, etc.										
General Maps	18	30	30	8	27	6	8,550	350	3,400	3,750
Provincial Maps	3	...	...	2	4	4	2,153	...	1,353	1,353
District Maps	19	9	9	5	7	12	2,891	...	2,741	2,741
Plans of Cities and Cantonments	33	84	19	8	18	...	1,470	...	1,470	1,470
Standard Maps	290	374	399	144	80	...	13,900	...	12,500	12,500
Index Maps	25	17	17	62	63	14	40,750	13[illegible]5	9,865	23,480
Technical Charts	13	13	18	13	4	...	590	...	590	590
Miscellaneous Maps and Plans, etc.	241	319	421	74	96	13	74,265	600	62,345	62,945
Transfers and Proofs	...	...	...	...	...	...	1,766	...	2,115	2,115
Departmental Forms	12	...	...	...	2	9	19,150	...	24,150	24,150
Type Printing	...	...	...	...	...	...	...	...	...	...
Total (Normal)	654	846	913	316	301	58	165,485	14,565	120,529	135,094
Cadastral Maps.										
Assam—										
Photo.-zincographs	287	287	258	219	219	...	15,803	...	15,803	15,803
Zincographs	69	...	...	69	69	...	5,809	...	4,689	4,689
Total	356	287	258	288	288	...	21,612	...	20,492	20,492
Bengal—										
Photo.-zincographs	222	222	230	228	228	...	2,508	...	2,508	2,508
Zincographs	65	...	...	65	65	...	715	...	715	715
Total	287	222	230	293	293	...	3,223	...	3,223	3,223
Burma—										
Photo.-zincographs	2,615	2,615	2,618	2,494	2,494	...	75,027	...	76,837	76,837
Zincographs	940	...	...	940	940	...	28,200	...	28,200	28,200
Total	3,555	2,615	2,618	3,434	3,434	...	103,227	...	105,037	105,037
North-Western Provinces—										
Photo.-zincographs	497	497	539	606	606	...	7,878	...	7,878	7,878
Zincographs	...	...	...	...	...	...	...	...	...	...
Total	497	497	539	606	606	...	7,878	...	7,878	7,878
Transfers and Proofs	...	...	...	...	...	...	9,372	...	...	...
Total (Cadastral)	4,695	3,621	3,645	4,621	4,621	...	145,312	...	136,630	136,630

.C OFFICE.

..ng the year 1898-99.

Type Printing.			Silver and other Printing.			Heliogravure and Electrotyping.				Value.
Pages or items.	Pulls.	Copies.	Silver prints.	Blue prints.	Miscellaneous prints.	Heliogravure plates.	Heliogravure prints.	Photo.-blocks.	Electrotypes.	
										R a. p.
...	...	...	...	...	...	...	...	...	...	3,354 4 9
...	...	...	...	...	...	...	...	...	...	1,301 11 0
...	...	...	...	...	...	...	...	...	...	3,488 12 3
...	...	...	...	238	...	...	...	...	...	1,474 14 3
...	...	...	...	912	...	...	...	...	...	11,156 9 0
...	...	...	...	30	...	...	...	...	...	2,486 14 3
...	...	...	...	...	...	...	...	...	...	273 7 6
...	...	...	47	236	...	17	4,292	1	8	15,968 0 0
...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	1,212 5 0
13,932	1,277,949	684,039	...	...	...	...	...	...	...	17,633 6 9
13,932	1,277,949	684,039	47	1,416	...	17	4,292	1	8	58,350 4 9
...	...	...	...	...	...	...	...	...	...	5,824 6 6
...	...	...	...	...	...	...	...	...	...	1,080 14 3
...	...	...	...	...	...	...	...	...	...	6,905 4 9
...	...	...	...	...	...	...	...	...	...	2,621 11 3
...	...	...	...	...	...	...	...	...	...	287 9 9
...	...	...	...	...	...	...	...	...	...	2,909 5 0
...	...	...	...	...	...	...	...	...	...	39,670 7 0
...	...	...	...	...	...	...	...	...	...	7,773 12 9
...	...	...	...	...	...	...	...	...	...	47,444 3 9
...	...	...	...	...	...	...	...	...	...	7,199 1 6
...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	7,199 1 6
...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	64,457 15 9

PHOTO

Statement of work done

Departments, etc.	Sheets or subjects.	Negatives and transparencies.	Photo.-zincographic: Photo-transfer prints.	Zinc plates transferred.	Zinc plates printed.	Stones.	Puls.
Adjutant General in India	20	11	10	...	8	12	17,500
" " in Mhow District	...	...	...	...	2	...	...
Administrative Medical Officer, Central Provinces	...	...	1	2	2	...	500
Agent and Chief Engineer, Assam-Bengal Railway	21	22	22	13	11	...	950
" " " " Bengal and North-Western Railway	26	50	50	16	16	...	1,600
Agent to the Governor General in Balúchistán	1	1	1	1	1	...	55
" " " " and Chief Commissioner, Rájputána and Central India	1	...	...	...	...	3	195
Architectural Surveyor, North-Western Provinces and Oudh	46	16	23	4	4	3	3,850
Asiatic Society, Bengal	...	...	...	...	...	...	1,440
Board of Revenue, Bengal	5	...	...	...	3	4	1,020
" " " North-Western Provinces and Oudh	3	10	5	2	1	...	200
Boundary Settlement Officer, Kashmir	28	39	39	2	2	...	24
Brigadier-General Commanding Mandalay District	...	...	...	...	2	...	70
Brigadier-General Commanding Pesháwar District	...	...	...	1	2	...	350
Calcutta Municipality	3	...	...	...	2	1	450
Chief Commissioner, Assam	1	...	...	...	...	1	9,000
" " Central Provinces	1	...	...	...	...	3	1,325
" Engineer, Bengal, Public Works Department	12	13	13	7	8	5	3,760
Chief Engineer, Bengal Doo4rs Railway extension	19	18	18	9	9	2	1,100
" " East Indian Railway	54	99	100	35	18	...	3,730
" " for Irrigation, Madras	...	...	...	...	...	...	...
" " Irrigation Works, Punjab	16	10	10	12	11	3	13,720
" " Public Works Department, Punjab	20	13	13	10	13	1	4,145
Collector of Customs, Calcutta	7	...	...	...	...	11	5,775
Commissioner of Excise, Bengal	7	...	...	...	...	7	3,430
" " " Punjab	2	...	...	...	...	4	860
" " " Police, Calcutta	1	...	...	...	...	2	2,168
Conservator of Forests, Bengal	1	...	...	...	...	2	60
Conservator of Forests, Tenasserim Circle	...	...	3	1	2	...	130
Deputy Adjutant General, Bengal Command	45	8	8	7	16	21	4,500
" " " Murree District	...	...	...	...	2	...	200
" Assistant Adjutant General, Oudh District	3	11	6	4	...	...	...
" Adjutant General, Punjab Command	3	7	7	4	8	...	690
" Assistant Adjutant General, Rangoon District	...	...	...	...	2	...	100
" " " " Secunderabad	3	4	4	3	3	...	1,500
" Commissioner, Ludhiána	1	...	...	...	...	1	100
Director General of Military Works	8	19	19	6	12	...	3,035
" " " Post Office, India	4	...	...	...	...	7	3,080
" " " Telegraphs	42	5	3	4	4	16	8,460
" " " Statistics	2	...	...	...	...	2	1,650
" Geological Survey of India	14	8	1	1	1	10	8,540
" Royal Indian Marine	12	26	...	...	...	...	...
" of Land Records and Agriculture, Assam	...	...	...	...	...	1	140
" " " " " " Bengal	25	2	2	4	29	14	16,240
" " " " " " Burma	...	...	...	...	19	...	1,298
" " " " Gwalior State	3	...	...	...	...	3	6,000
" " Public Instruction, Bengal	4	...	...	...	...	4	2,800
" " Land Records, Punjab	1	4	...	...	...	...	...
Engineer-in-Chief, Dhubri-Gauháti Railway Survey	1	...	...	...	1	1	200
" " " E. B. State Railway	9	8	8	4	5	1	280
" " " Vizianagram	...	...	...	2	3	...	300
Executive Engineer, Eastern Berar Division	...	...	...	...	...	1	80
" " Kashmir Railway Survey	1	...	...	...	...	1	250
" " Simla Provincial Survey	6	14	14	6	12	...	600
Examiner of Telegraph Accounts	2	...	...	...	...	2	400
General Officer Commanding Allahabad District	2	8	8	2	...	...	...
" " " The Forces, Bengal	2	6	6	1	...	...	...
" " " Bundelkhand District	1	4	4	2	2	...	100
" " " Meerut District	3	12	12	4	2	...	400
" " " Punjab Frontier Force	1	2	2	1	1	...	70
" " " Ráwalpindi District	...	...	...	...	2	...	240
" " " Sind District	2	6	6	2	2	...	300
Government of India, Revenue and Agriculture Department	29	54	2	2	3	6	18,780
" " Foreign Department	19	9	9	5	7	12	815
" " Home Department	2	...	...	4	16	2	11,880
" " Linguistic Survey	9	6	6	7	6	8	598
" " Military Department	6	7	7	9	11	1	3,420
Carried over	560	532	442	199	286	178	174,453

IC OFFICE.

during the year 1898-99.

Photographic Printing.			Silver and other Printing.			Heliogravure and Electrotyping.				Value.		
Number of copies.												
Coloured.	Uncoloured.	Total.	Silver prints.	Blue prints.	Miscellaneous prints.	Heliogravure plates.	Heliogravure prints.	Photo.-Blocks.	Electrotypes.	£	s.	p.
6,400	6,200	12,600	...	4	...	...	...	...	...	1,833	3	0
...	165	165	...	...	...	...	...	...	...	43	4	3
...	250	250	...	...	...	...	...	...	...	26	14	6
...	2,050	2,050	...	...	...	...	...	...	...	482	12	3
...	2,400	2,400	...	...	...	...	...	...	...	1,028	10	9
...	55	55	...	...	...	...	...	...	...	21	13	3
65	...	65	...	...	...	...	...	...	...	74	10	0
...	12,650	12,650	...	...	...	30	15,430	...	...	4,997	5	0
720	...	720	...	...	...	...	...	...	...	88	4	0
620	...	620	...	...	...	...	...	...	...	229	13	0
...	200	200	...	26	...	...	...	...	...	144	13	0
...	24	24	...	...	...	...	...	...	...	565	3	9
...	70	70	...	...	...	...	...	...	...	19	7	0
...	175	175	...	...	...	...	...	...	...	74	14	6
450	...	450	...	...	...	...	...	...	...	186	4	0
...	9,000	9,000	...	...	...	...	...	...	...	538	5	0
375	150	525	...	...	...	...	...	...	...	101	1	0
1,310	410	1,720	...	...	...	...	...	...	...	773	12	0
100	1,800	1,900	...	...	...	...	...	...	...	483	6	0
...	3,130	3,130	...	...	...	1	1	...	...	2,113	13	0
...	...	...	17	...	...	...	...	...	...	17	8	0
...	17,560	17,560	...	...	...	...	...	...	...	1,395	2	6
...	6,320	6,320	...	...	...	...	...	...	...	900	8	3
3,675	...	3,675	...	...	...	...	...	...	...	666	14	0
3,430	...	3,430	...	...	...	...	...	...	...	348	3	0
430	...	430	...	...	...	...	...	...	...	76	15	0
1,084	...	1,084	...	...	...	...	...	...	...	147	13	0
...	60	60	...	...	...	...	...	...	...	16	10	0
...	130	130	...	...	...	...	...	...	...	49	12	0
3,920	400	4,320	...	...	...	...	...	...	...	1,591	3	6
...	100	100	...	...	...	...	...	...	...	35	6	6
...	...	...	...	10	...	...	...	...	...	149	8	0
...	385	385	...	...	...	...	...	...	...	271	6	9
...	100	100	...	...	...	...	...	...	...	29	0	6
...	500	500	...	...	...	...	...	...	...	269	1	6
...	100	100	...	...	...	...	...	...	...	210	0	0
...	3,235	3,235	...	...	...	...	...	...	...	857	13	9
1,760	...	1,760	...	...	...	...	...	...	...	274	0	0
50	21,910	21,960	...	2	...	...	...	...	...	1,486	8	0
...	1,650	1,650	...	...	...	...	...	...	...	150	13	0
2,180	3,000	5,180	23	...	...	8	2,659	7	...	1,427	5	6
...	...	...	...	...	...	12	3,012	...	...	1,321	8	0
...	140	140	...	...	...	...	...	...	...	26	15	0
8,340	860	9,200	...	3	...	...	...	...	...	2,015	4	6
...	1,298	1,298	...	...	...	...	...	...	...	606	12	0
...	9,000	9,000	...	...	...	...	...	...	...	737	12	0
2,800	...	2,800	...	...	...	...	...	...	...	175	8	0
...	...	...	...	12	...	...	...	...	...	31	0	0
100	...	100	...	...	...	...	...	...	...	47	8	0
100	160	260	...	...	...	...	...	...	...	148	13	0
...	100	100	...	...	...	...	...	...	...	56	11	3
...	80	80	...	...	...	...	...	...	...	13	10	0
...	250	250	...	...	...	...	...	...	...	210	8	0
...	600	600	...	...	...	...	...	...	...	408	12	3
...	400	400	...	...	...	...	...	...	...	22	9	0
...	...	...	...	...	...	...	...	...	...	102	0	8
...	...	...	...	...	...	...	...	...		78	12	0
...	50	50	...	...	...	...	...	...	...	78	12	0
...	200	200	...	...	...	...	...	...	...	259	3	6
...	70	70	...	...	...	...	...	...	...	53	13	3
...	120	120	...	...	...	...	...	...	...	93	4	0
...	300	300	...	...	...	...	...	...	...	190	5	3
850	57,120	57,970	...	80	...	30	35,280	...	...	8,663	15	6
247	349	596	...	...	...	...	...	...	...	1,134	7	9
600	5,640	6,240	...	...	...	...	...	...	...	1,311	8	9
106	166	272	...	...	...	...	...	...	...	420	3	9
40	1,640	1,680	...	...	...	...	...	...	...	680	4	3
39,752	172,722	212,474	40	137	...	81	56,382	7	...	43,088	15	0

PHOTOG

Statement of work

Departments, etc.	Sheets or subjects.	Negatives and transparencies.	Photo-Zincographic: Photo-transfer prints.	Zinc plates transferred.	Zinc plates printed.	Stones.	Pulls.
Brought forward	560	532	442	199	286	178	174,453
Government of India, Public Works Department, Railway Construction	139	82	82	64	106	16	83,015
Government of Bengal, Financial Department	...	...	...	...	...	...	686
" " Municipal Department	1	...	...	...	7	1	982
" " Public Works Department, Irrigation Branch	54	70	70	29	54	42	21,560
" " Railway Department	1	...	...	...	...	3	750
" " Revenue and General Department	2	...	...	...	5	2	25,902
Government of Bombay	1	2	...	...	...	...	...
Government of Madras, Public Works Department	17	...	...	...	...	...	...
Government of Punjab, " " "	1	...	...	1	1	1	700
Indian Famine Commission	1	...	...	...	[illegible]	1	13,240
Indian Museum, Calcutta	9	12	...	...	...	1	500
Inspector General of Artillery in India	1	1	1	2	1	...	000
" " Civil Veterinary Department	1	...	...	...	5	1	1,800
" " Jails, Bengal	6	3	...	...	...	3	125
" " Forests, Government of India	7	7	7	...	...	1	1,000
" " Police, Bengal	36	11	6	4	8	16	10,223
" " Registration, Bengal	1	...	...	...	...	2	2,400
Master of the Mint, Calcutta	...	...	...	...	...	...	...
Meteorological Reporter to the Government of India	110	30	32	23	37	15	84,910
" " " Bengal	5	...	..	...	5	6	70,359
Military Secretary to the Viceroy	3	2	2	..	...	5	412
Officer Commanding Fort William, Calcutta	2	2	2	2	2	...	100
" " Oudh District	3	12	12	...	...	...	...
" in charge, Bengal Secretariat Book Depôt	...	...	...	...	...	...	27
" " of Records, Government of India	7	8	5	4	...	...	...
Photographic Society of India	4	4	...	...	...	...	...
Port Commissioners, Calcutta	2	4	10	4	4	...	500
" Officer and Registrar of Wrecks, Calcutta	4	6	6	2	2	4	820
Principal, Civil Engineering College, Sibpur	...	...	...	...	...	...	...
" Dacca College	...	...	...	...	...	...	200
Quarter Master General in India	4	1	1	3	6	7	4,084
Rangoon Municipality	116	155	310	173	...	...	...
Resident in Nepál	...	...	...	1	...	...	...
Sanitary Commissioner, Bengal	6	..	...	...	...	8	5,680
" " with the Government of India	2	1	1	2	2	4	5,700
Sanitary Engineer, Bengal	12	18	18	6	6	...	1,800
Secretary, Government of Burma	43	4	...	...	...	1	000
" for Berar to the Resident at Hyderabad	...	...	...	...	1	...	170
" Lady Dufferin's Fund	1	...	...	...	...	2	3,000
" to the Plague Commission, Bengal	3	...	...	...	...	1	2,610
" Indian Plague Commission, Bombay	14	...	2	3	18	14	77,840
Settlement Officer, Bassein, Burma	...	...	...	...	...	...	400
" " Hanthawaddy	...	...	...	...	...	1	120
State Engineer, Kashmir Darbar	2	1	1	1	1	2	451
Superintendent, Civil Veterinary Department	4	1	1	...	...	5	2,000
" Forest Surveys, Bengal	...	...	...	...	...	1	1,000
" " " Dehra Dún	5	7	...	...	...	3	1,320
Superintending Engineer, Irrigation Circle, Upper Burma	9	7	7	17	17	...	1,275
Superintendent, Government Central Branch Press, Simla	1	2	2	...	...	...	...
Superintending Engineer, 3rd Circle, Irrigation Works, North-Western Provinces and Oudh	9	..	...	...	...	4	122
Superintending Engineer, Orissa Circle	...	...	...	...	...	...	...
Superintendent of Harness and Saddlery Factory, Cawnpore	2	...	...	...	...	2	512
Superintendent, Government Printing, India	209	73	102	7	11	56	29,572
" " Press, North-Western Provinces and Oudh	2	...	...	...	...	4	1,878
Superintendent of Land Records, North-Western Provinces and Oudh	4	...	...	...	..	2	6,000
Superintendent of Stationery	5	...	...	...	4	7	10,9 0
" of Land Records Survey, North-Western Provinces and Oudh	...	...	...	...	...	1	200
Superintendent of Telegraphs, Stores	1	.	...	...	...	1	1,920
Traffic Manager, East Indian Railway	...	...	...	...	2	...	475
" Superintendent, Eastern Bengal State Railway	...	...	...	...	2	..	400
Vice-President to the Commissioners for Inspection of Steam Boilers	...	..	...	...	...	...	...
Special work done for trade and private individuals	92	42	31	21	30	2	7,527
Pulls and proofs	...	...	...	...	...	...	2,343
TOTAL	1,524	1,100	1,153	508	620	420	671,423

[illegible]HIC OFFICE.

[illegible]tments during the year 1898-99—(continued).

Lithographic Printing.			Silver and other Printing.			Heliogravure and Electrotyping.				Value.		
Number of copies.												
Coloured.	Uncoloured.	Total.	Silver prints.	Blue prints.	Miscellaneous prints.	Heliogravure plates.	Heliogravure prints.	Photo-Blocks.	Electrotypes.	*R*	*a.*	*p.*
39,752	172,722	212,474	40	137		81	56,382	7		43,088	15	0
8,365	61,866	70,231	...	...	...	...	...	...	...	7,824	14	9
686	...	686	...	...	...	...	...	...	...	27	13	0
140	702	842	...	...	...	...	...	...	...	189	4	0
5,714	5,050	10,764	...	2	...	...	...	...	...	4,139	9	9
250	...	250	...	...	...	...	...	...	...	295	0	0
19,143	...	19,143	...	...	...	...	...	...	...	1,382	1	0
...	...	...	...	...	...	1	1	...	...	36	0	0
...	...	...	...	...	...	...	...	17	...	612	0	0
...	700	700	...	...	...	...	...	...	...	149	12	0
3,310	...	3,310	...	...	...	...	...	...	...	806	12	0
...	1,500	1,500	...	...	...	6	13,206	...	...	2,121	2	0
...	600	600	...	...	...	...	...	...	...	52	13	3
300	...	300	...	...	...	...	...	...	...	313	8	0
...	175	175	...	3	...	...	...	...	...	368	7	0
...	7,000	7,000	...	...	...	...	...	...	...	226	5	0
4,245	1,700	5,945	...	...	...	...	...	8	...	753	0	3
1,200	...	1,200	...	...	...	...	...	...	...	162	15	0
...	...	...	2	...	...	...	...	...	...	2	8	0
9,600	139,445	149,045	...	...	...	...	...	...	...	4,397	12	6
146	56,180	56,326	...	...	...	...	...	...	...	1,066	7	0
200	12	212	...	...	...	...	...	...	...	384	14	0
...	50	50	...	...	...	...	...	...	...	74	15	3
...	...	...	...	...	...	...	...	...	...	134	0	0
...	27	27	...	...	...	...	...	...	...	7	8	0
...	...	...	...	2	...	1	1	...	...	180	12	0
...	...	...	...	...	...	4	3,204	...	...	195	0	0
...	500	500	...	...	...	...	...	...	...	262	4	0
260	300	560	...	...	...	...	...	...	...	267	10	6
...	...	...	...	...	...	...	100	...	...	12	0	0
...	200	200	...	...	...	...	...	...	...	38	0	0
1,280	434	1,714	...	...	...	...	...	...	...	976	4	9
...	...	...	...	...	...	...	...	...	...	4,410	12	0
...	...	...	...	...	...	...	...	...	...	4	12	0
3,550	710	4,260	...	...	...	...	...	...	...	552	11	0
950	950	1,900	...	...	...	...	...	...	...	549	13	0
...	3,600	3,600	...	...	...	...	...	...	...	367	15	0
...	600	600	...	...	...	7	5,004	45	...	2,268	2	0
...	340	340	...	...	...	...	...	...	...	9	8	9
1,500	...	1,500	...	...	...	...	...	...	...	128	12	0
...	7,830	7,830	...	...	...	...	...	...	...	308	13	0
17,570	12,580	30,150	...	...	...	...	...	...	...	5,676	4	6
...	400	400	...	...	...	...	...	...	...	80	0	0
...	120	120	...	...	...	...	...	...	...	31	4	0
150	151	301	...	...	...	...	...	...	...	119	12	0
250	1,500	1,750	...	...	...	...	...	...	...	100	12	0
...	1,000	1,000	...	...	...	...	...	...	...	193	8	0
...	1,320	1,320	...	...	...	5	2,405	...	...	687	0	0
...	600	600	...	...	...	...	...	...	...	291	4	0
...	...	...	...	...	...	...	...	...	...	23	8	0
...	142	142	...	...	...	...	...	...	...	329	9	0
...	...	...	...	52	...	...	...	...	...	68	0	0
...	524	524	...	...	...	...	...	...	...	34	8	0
4,074	37,261	41,335	...	1	...	1	11	...	...	3,912	10	9
381	735	1,116	7	...	...	...	...	...	...	410	8	0
...	24,000	24,000	...	...	...	...	...	...	...	384	11	0
...	10,960	10,960	...	...	...	...	...	...	...	608	12	0
...	200	200	...	...	...	...	...	...	...	43	3	0
...	960	960	...	...	...	...	...	...	...	50	0	0
...	475	475	...	...	...	...	...	...	...	116	9	6
...	400	400	...	...	...	...	...	...	...	128	12	9
...	...	...	...	...	...	...	...	...	...	41	9	0
600	11,380	11,980	24	18	...	5	1,908	...	...	2,270	6	0
...	2,212	2,212	...	...	...	...	...	...	...	...		
123,616	570,113	693,729	53	215	...	111	82,222	77	...	94,813	14	9

*For colouring.

MATHEMATICAL INSTRUMENT OFFICE.

TABLE A.

Details of Issues to and Receipts from Provinces and Departments during the Financial year 1898-99.

PROVINCES AND DEPARTMENTS.	VALUE OF			
	Receipts.	Issues.	Debits.	Credits.
	R	R	R	R
Assam	441	5,891	5,450	...
Bengal Civil	10,180	21,299	11,119	...
„ Military	Bengal Command	1,146	6,538	5,392	...
„ „	Punjab „	12,959	17,271	4,312	...
Bombay Civil	1,707	4,681	2,974	...
„ Military	111	2,850	2,739	...
Burma	865	17,547	16,682	...
Central Provinces	440	4,795	4,355	...
Foreign States, Berar	...	246	246	...
Forests	...	1,056	1,056	...
Geological Survey and Museums	...	225	225	...
Guaranteed Railways, East Indian Railway	150	4,565	4,415	...
Madras Civil	...	706	706	...
„ Military	836	2,573	1,737	...
Marine	...	1,334	1,334	...
Meteorological Department	...	1,771	1,771	...
Mint	..	345	345	...
North-Western Provinces and Oudh	4,408	15,217	10,809	...
„ „ State Railway, Public Works Department	2,220	12,046	9,826	...
Public Works Department, Military Works	323	1,563	1,240	...
Public Works Department, Coorg	218	77	...	141
„ „ „ Baluchistan, Railway Branch	...	826	826	...
Punjab	4,945	9,914	4,969	...
Rajputana, Public Works Department, and Central India	325	670	345	...
Survey Department (Field Parties)	21,387	83,366	61,979	...
„ „ Head-Quarters Offices Calcutta and Dehra Dún	6,238	8,905	2,667	...
Burma-China Boundary Commission	...	1,032	1,032	...
Telegraph	...	230	230	...
TOTAL	68,899	2,27,539	1,58,781	141
NET DEBI	...	...	1,58,640	...
CASH SALES	...	...	50,664	...
GRAND TOTAL	...	...	2,09,304	...

MATHEMATICAL INSTRUMENT OFFICE.

TABLE B.

Instruments, etc., purchased in the local market during 1898-99.

SPECIFICATION.	Number.	Value.	
		R	*a.*
Instruments.			
Barometers, aneroid, ordinary, pocket	4	250	0
Cases, leather, and Morocco, spare	103	302	12
Chronographs, watch pattern	9	225	0
Clinometers, road reflecting, Cook's pattern	24	1,344	0
Clocks	7	172	0
Cords for range finders	1,000	210	0
Compasses, drawing, ordinary, 5″	252	252	0
„ magnetic, rectangular, 2″ and 2½″	20	140	0
„ „ „ „ 5″	237	3,081	0
„ „ „ „ 6″	124	1,860	0
„ prismatic, card dial, 2″ and 2½″	2	50	0
„ „ Hutchinson's pattern	3	96	0
„ proportional, brass, 6″	24	480	0
Covers for plane tables	66	348	4
Curves, French, wooden, sets	2	12	0
„ Railway, card board, large, sets	2	75	0
Glasses, binocular, large	9	360	0
„ „ small	8	270	0
„ magnifving or reading, folding, 1″ to 2″	6	7	8
„ measuring for rain-gauges, 5″	2	13	0
Haversacks	24	36	8
Lamps, Argand	15	45	0
„ bull's eye	12	58	10
Levels, spirit, in wooden case, 4″ to 7″	24	22	8
„ „ „ „ 8″ to 10″	10	11	4
„ „ „ „ 11″ to 15″	2	2	4
Map printing machines, Gastrell's	6	375	0
„ „ „ Ordnance	12	570	0
Opisometers	1	10	8
Cords for mekometer	6	396	0
Pins for chains, ordinary	4,000	250	0
Plane tables, deal, survery pattern	300	2,100	0
Protactors, rectangular, wooden	32	76	0
„ brass, semicircular, plain	18	234	0
Presslers borers for hard wood	36	576	0
Rules, parallel on rollers, brass, 12″	1	30	0
„ „ „ „ 15″ and 18″	9	432	0
„ sight, wooden	514	1,542	0
Scales, architects, boxwood, sets	8	200	0
„ „ „ single	18	87	12
„ diagonal, wooden	1,400	787	8
„ offsets, single, wooden	18	6	12
„ plotting, sets, ebonite	12	312	0
„ „ single, wooden	18	40	8
Squares, set single, ebonite	108	126	0
„ optical	687	4,465	8
Stands for plane tables, survey pattern	705	4,935	0
„ „ „ military pattern	25	450	0
Staves, levelling, Sopwith's, telescopic	120	2,050	0
Stencil plates, various	5	18	4
Tapes, metallic, 50′	50	275	0
„ „ other sizes	9	15	12
Thermometers, chemical, or Traveller's, from 0° to 400°	12	84	0
„ clinical	6	37	0
Carried over	10,127	30,297	2

MATHEMATICAL INSTRUMENT OFFICE.

TABLE B.

Instruments, etc., purchased in the local market during 1898-99—concluded.

SPECIFICATION.	Number.	Value. R	a.
Instruments—concluded.			
Brought forward	10,127	30,297	2
Thermometers, common, in tin cases	30	69	6
„ grass	2	40	0
„ maximum, self-registering	12	240	0
„ oven	6	270	0
Trunks, mule	12	186	0
Umbrellas, surveying	72	1,081	8
TOTAL	10,261	32,183	10
Books.			
Hints to travellers	2	14	0
Manual of Surveying, Thuillier's	2	24	0
Nautical almanacs	62	155	0
Tables, log, Chamber's	13	43	14
„ „ Hutton's	5	45	9
„ „ Shortrede's, sines, etc.	12	270	10
Tables, Traverse, Boileau's	6	54	12
Merces, Income table	1	1	8
Addition exchange tables	1	1	8
TOTAL	104	610	13
Sundries.			
Brushes, stencil	72	36	0
Glass, ink, bottles	36	13	8
Acetylene, lamp fitting	5	241	10
Cards for Richard barographs	100	18	12
Charts for sun-shine recorder	365	40	0
Charts for anemographs	500	93	12
Chimneys	99	30	9
Elastic rubber bands	12	0	12
Eye pieces, for levels	2	30	0
Frames and fittings, for clinometer	80	1,352	0
„ „ with folding sights	18	405	0
Frames, for levelling staves	30	450	0
Indelible pad, for Yost Type Writer	1	12	0
Lactometers	26	71	8
Lamps, Hink's, duplex, with wicks	5	20	0
Lamps, silvered, with 18 wicks	2	36	4
Observatory tents with round sheet of canvas	2	208	8
Printing ink, black	5	7	8
„ „ red	5	12	8
Search light lanterns	9	51	12
Seismoscopes	6	390	0
Shades for lanterns	6	3	12
Stencil ink, black	53	26	8
„ ink	3	2	4
„ ink, red	9	6	12
Tin boxes, small	12	6	0
Tool chest	1	50	0
Wicks, for lamps	36	2	7
TOTAL	1,500	3,619	10
TOTAL OF BOOKS	104	610	13
TOTAL OF INSTRUMENTS	10,261	32,183	10
SUM TOTAL	11,865	36,414	1

MATHEMATICAL INSTRUMENT OFFICE.

TABLE C.

Instruments, etc., manufactured in the Mathematical Instrument Office during 1898-99.

SPECIFICATION.	Number.	Value. £	Value. s.
Instruments.			
Boards, drawing, deal	28	433	0
Chains, iron, 30′	110	275	0
,, ,, 66′	900	3,150	0
,, steel	125	1,375	0
Clinometers, survey pattern	72	2,520	0
Combs, acre, card-board	4,200	1,575	0
Compasses, magnetic, rectangular, 5″	25	325	0
,, ,, ,, 6″	13	195	0
Curves, Railway, wooden, single	17	1	4
Gauges, writing	91	167	8
Girder, Tester	2	400	0
Glasses, copying or tracing	5	190	0
Glasses, magnifying or reading, folding	4	8	0
Heliotropes, 9″	7	315	0
Hold-alls, leather	25	425	0
Ink rollers	30	66	0
Instruments, drawing, electrum, 2nd sort	1	61	12
Lamps, Argand	1	150	0
Levels, Field Service	6	192	0
Level, spirit, in wooden case, 8″ to 10″	1	2	0
Pins, for chains, ordinary	2,665	215	2
Plane-tables, deal, Survey	549	3,647	0
,, ,, Military	38	464	0
,, ,, ,, Hutchinson's, complete	4	240	0
Pluviometers, Symon's	63	379	0
Protractors, card-board, circular, 5″	200	62	8
,, ,, ,, 9″ and 12″	100	125	0
Rods, measuring	107	160	8
Rules, flat, wooden, plain, 12″ and 18″	497	93	3
,, sight, brass	24	240	0
Scales, Bengali, metal	2	10	0
,, card-board, miscellaneous	725	331	4
,, common, various sizes, metal	28	28	0
,, diagonal, card-board	6,000	1,500	0
,, ,, metal, 6 inches to the mile	2	15	0
,, ,, ,, miscellaneous	11	110	0
Sheets, celluloid	973	637	0
Set squares, single, wooden	11	9	0
Stamps for conventional signs	38	95	0
Stands, for heliotropes	65	1,040	0
,, ,, levels, other kind	3	105	0
,, ,, plane-tables, survey pattern	100	700	0
,, ,, theodolites, transit, 5″	21	950	0
,, ,, ,, ,, 6″	17	770	0
,, ,, ,, ,, Railway	4	180	0
,, ,, ,, Universal	5	175	0
,, Miscellaneous	7	17	8
Staves, levelling, Roorkee, single	20	240	0
,, ,, Sopwith's telescopic	45	1,125	0
Stencil plates, various	279	495	12
Thermometers, maximum and minimum, sets, 6″	1	19	8
,, ,, ,, ,, 9″	1	17	8
TOTAL	18,268	26,023	5

MATHEMATICAL INSTRUMENT OFFICE.

TABLE C.

Instruments, etc., manufactured in the Mathematical Instrument Office during 1898-99 —concluded.

SPECIFICATION.	Number.	Value. R	a.
Sundries.			
Boxes of sorts	25	37	4
Plummets, brass	20	20	0
Back-boards for barometers	16	240	0
Board for thermometer, maximum and minimum	1	1	0
Bolts and nuts for plane-tables	20	5	0
Brass, plate	2	3	0
Brass, roller, 12″ long, 3″ diameter	1	12	0
Brushes for theodolite	5	5	8
Bubble-tubes for theodolite	1	18	0
Cases, deal-wood, with hasps and padlocks	2	10	0
Cash box	1	20	0
Clamping screws for plane-table	6	5	10
Cylindrical piece of pluviometer	1	3	0
Cylinder vessel	1	2	8
Frames for tents	2	150	0
Handles for chains	2	1	0
Hinges, brass	12	12	0
Medicine box	1	3	8
Mercury bottles with 4 lb mercury	2	18	0
Numbers for chains	61	5	2
Nuts for plane-table stands	5	1	4
„ for theodolite stands	2	1	4
Pins for theodolite	15	3	12
Plumb, level	1	1	0
Reservoirs of rain-gauge with bottles, complete	2	5	0
Rope, chain, 66′, with handle	18	90	0
Screws for plane-tables	5	7	8
Slate and pencil for typograph	1	4	8
Spiders, web	4	20	0
Tops, brass, for rain-gauge	6	27	0
Turnscrews, for theodolite	3	2	4
Type-frames, for printing machine	15	79	8
Washers, brass	40	16	14
Water-levels	6	45	0
Wrenches for theodolite	1	1	4
TOTAL	306	878	10
TOTAL OF INSTRUMENTS	18,268	26,023	5
SUM TOTAL	18,574	26,901	15

MATHEMATICAL INSTRUMENT OFFICE.

TABLE D.

List of principal instruments repaired in Workshop during the financial year, 1898-99.

SPECIFICATION.	Number.
Anemograph	1
Anemometers	29
Arithmometer	1
Balances, chemical	3
Bars, lengthening	3
Barographs	2
Barometers of sorts	97
Boards, drawing	2
Chains of sorts	67
Chronographs	2
Chronometers of sorts	6
Chrono-micrometers of sorts	2
Clinometers	135
Clocks	17
Compasses, azimuth	1
„ beam	3
„ bow, pen	116
„ „ pencil	14
„ „ dividers	8
„ drawing	430
„ magnetic rectangular	118
„ marine	8
„ mining	1
„ prismatic	126
„ proportional	9
„ subtense	1
„ surveying	9
Cards for compasses	7
Cords and reels	34
Deodrometer	1
Eyelet machine	2
Glasses, binocular	47
„ magnifying	1
Heliographs	13
Heliotropes	43
Hold-alls, leather	22
Hydrometers	43
Hygrometers	8
Indicators	2
Instruments, drawing, of sorts	45
Lamps of sorts	10
Lens	1
Levels of sorts	169
„ spirit	13
Map printing machines	5
Mekometers	172
Meter current	1
Miscroscopes	1
Mining dial	1
Pens double or road	1
„ drawing	199
Pantagraphs	8
Perambulator	1
Pins of sorts	122
Plane-tables	47
Planimeters	14
Pointers, station	7
Protractors	2
Carried forward	2,253

MATHEMATICAL INSTRUMENT OFFICE.

TABLE D.

List of principal instruments repaired in Workshop during the financial year, 1898-99—concluded.

SPECIFICATION.	Number.
Brought forward	2,253
Quintants	11
Range-finders	11
Rain-gauges	6
Rules of sorts	126
Scales of sorts	92
Scott's sights B. L. telescopic	142
Set squares	2
Sextants	21
Squares, optical	236
Stands, for compasses	63
„ „ heliographs	3
„ „ heliotropes	9
„ „ levels	91
„ „ plane-tables	50
„ „ theodolites	53
Staves, levelling	118
Sundials	2
Sunshine Recorder	1
Tapes	782
Telemeters	37
Telescopes	264
Theodolites	122
Thermographs	2
Thermometers	71
Time-pieces	2
Type writers	17
Watches	44
TOTAL OF PRINCIPAL INSTRUMENTS REPAIRED	4,631
„ „ MINOR INSTRUMENTS REPAIRED	1,237½
TOTAL OF ALL INSTRUMENTS REPAIRED	5,868½

MATHEMATICAL INSTRUMENT OFFICE.

Profit and Loss account of the Workshop for the financial year, 1898-99.

Debits.	R	a.	Credits.	R	a.	R	a.
Workshop establishment (less proportion debitable to the Store Branch for cleaning and adjusting serviceable instruments)	43,061	10	By repairs for public officers on book debit	14,703-5		...	
One-third of office establishment	2,758	5	„ repairs for public officers on payment	10,004-15		24,708	4
Pay of Material Storekeeper for the whole year	780	0	„ repairs for stock			43,834	15
Workshop contingencies as distinguished from materials purchased	3,167	14	„ manufacture for stock :—				
Value of materials :—							
For ordinary work	29,679	8	instruments			25,358	7
„ general workshop use			packing-cases			1,693	4
„ manufacture of packing cases			„ manufacture of material			2,591	0
Paid for repairs	...						
Wear and tear of plant	867	7					
Half of rent at R600 per mensem	3,600	0					
Printing and stationery	472	15					
Four per cent. on value of tools and plant amounting to R1,41,997-2-0	5,679	14					
Half of rates and taxes, etc.	702	0					
Liability for pensions	5,175	6					
Profit	2,240	15					
Total	98,185	14	Total			98,185	14

TRIGONOMETRICAL BRANCH OFFICE, DEHRA DÚN.

Narrative Report of MR. J. ECCLES, M.A., *Superintendent, 2nd grade, in charge Computing Party, Season 1898-99.*

The experimental base line in the Survey Office compound was re-measured for the instruction of the newly appointed officers of the Imperial and Provincial Services, and a short base of 100 feet was laid down by two measurements for comparison of chains and wires.

The Solar Eclipse Report containing the results of observations at Sahdol, Pulgáon, and Dumráon was completed and issued.

Lieutenant A. Mears, I.S.C., having gone through his course of instruction in the methods of astronomical observations and computations of the Trigonometrical Branch and in levelling and plane-tabling, was transferred to No. 4 Party on the 29th October 1898. Lieutenants H. Wood, R.E., H. McC. Cowie, R.E., B. R. Daunt, I.S.C., C. P. Gunter, R.E., E. T. Rich, R.E., and A. A. Crookshank, R.E., on their appointment to the department, were posted to this office, and were put through a course of astronomical observations and triangulation, and taught the methods of computations used in the department. For a short time they were attached to the Training School to learn plane-tabling. Lieutenant Daunt was attached to the office of the Superintendent of Land Records Surveys, North-Western Provinces and Oudh, from 18th November 1898 to 22nd February 1899 for instruction in the work of the Revenue Branch. He rejoined this office on the 23rd February, but owing to failing health he proceeded on leave on medical certificate on the 15th May 1899. Lieutenants Wood and Cowie completed their course and were posted to field parties at the end of the year.

Captain H. A. D. Fraser, R.E., before proceeding to England to consult Professor Rücker regarding the Magnetic Survey of India, was posted to this office to receive instruction in the subject. Four officers from the department of the Quarter-Master General in India were temporarily attached to this office for instruction in exploration work, of whom two are still under instruction.

Six Sub-Assistant Superintendents were transferred from the Revenue Branch for instruction in topographical work and were attached to the Training School. Two of them had to proceed on medical leave owing to ill-health before they could complete their course; but the others with the seven newly appointed Probationary Sub-Assistant Superintendents received a regular course of professional instruction in the use of the plane-table, theodolite, and level, and were shown the processes in the various sections of the Trigonometrical Branch Office. They were also instructed in topographical drawing and in the computations of the Topographical Branch. All of these completed their course and were transferred to field parties at the end of the year.

In the training school, in addition to the above, a class of fifteen Probationary Sub-Surveyors were instructed in the use of the plane-table and theodolite, and all of them passed the final examination and were posted to field parties. Two Sub-Surveyors of No. 15 Party received special training in theodolite traversing, triangulation, and plane-tabling; they were also taught how to finish up their work.

The instruction given in the Training School consisted of plane-tabling on the 1-inch, 4-inch, and 36-inch scales, theodolite traversing both by chain and bar-subtense, levelling with the dumpy level, model surveying, star observations for time, latitude and azimuth, drawing of scales, graphical projection and hand-printing.

At the special request of the Military Secretary, His Excellency the Viceroy's stables were surveyed on the 36-inch scale.

The following changes took place in the *personnel* of the office during the year:—Mr. J. M. Kennedy, Extra Assistant Superintendent, who was posted to this office on the 24th November 1898, was transferred to the North-Western Provinces Drawing Office on the 15th September 1899. Munshi Golam Muhammad, draftsman, died. Babu Navin Chandra Gupta, copyist, resigned, and Babu Mukundananda Acherya was appointed as copyist in the computing section.

The cost of the computing section under its various class heads and the percentage thereof, together with those of the three preceding years, are given in the following statement:—

CLASS.	COST IN RUPEES.	PERCENTAGE OF COST.			
	1898-99.	1898-99.	1897-98.	1896-97.	1895-96.
1. Records, Library	938	3·3	3·6	3·0	2·9
2. Accounts, Returns, Correspondence	2,370	8·3	9·2	6·4	5·2
3. Supply of Data, etc.	425	1·5	6·6	0·8	1·7
Carried over	3,733	13·1	17·4	10·2	9·8

Class.	Cost in Rupees.	Percentage of Cost.			
	1898-99.	1898-99.	1897-98.	1896 97.	1895-96.
Brought forward	3,733	13·1	17·4	10·2	9·8
4. Computations	6,122	74·3	67·9	79·9	78·5
5. Preparation of Press copy	5,653				
6. Examination of Press proofs	9,410				
7. Ditto charts	385	1·4	1·5	1·9	2·9
8. Protection of stations	1,457	5·1	4·0	3·4	3·3
9. Miscellaneous	1,192	4·2	5·0	3·2	4·4
10. Meteorology, etc.	548	1·9	4·2	1·4	1·1
11. Extra-departmental work	...	...	...	...	...
Total	28,500	100	100	100	100

From the above table, it will be seen, that the working power of this section has been distributed much in the same way as in the preceding years.

The following is an account of the work done under the several classes shown in the foregoing table:—

Class 1.—Records, Library, etc.—Four fresh instalments of field records were received during the year; these together with those already in the office have received the usual care and attention. The three standard copies of the library catalogue have been kept up to date.

Class 2.—Accounts, Returns, and Correspondence.—In this is included the preparation of indents, estimates, monthly detailed and abstract progress reports, annual reports, stock returns of office stores, and various other items.

Class 3.—Supply of Data.—Thirteen requisitions for data and 68 indents for forms were received and complied with; in all about 42,000 copies of professional and other forms were issued during the year.

Class 4.—Computations.—The following are the details:—

Great Arc Meridional Series, Section 18° to 24°.—Certain secondary triangles were re-computed; this was necessitated by Narsula and Chittial stations being found to be identical.

North-east Longitudinal Series.—Preparation of name list and selection of points for computation being proceeded with.

Table of horizontal distances when the slope of the hill and the angle subtended by the bar are known.—Computed and prepared.

Spirit-levelled heights, section Vizagapatam to Raipur.—A portion was adjusted.

Heights in China obtained by Captain Wingate.—Barometric heights were computed.

Captain Deasy's explorations in Tibet, 1897-98 and 1898-99.—Reduction being proceeded with. The work includes the computations of astronomical azimuths, latitudes and time, geodetic latitudes, longitudes and azimuths, and triangles.

In addition to the above the computers were employed on the following:—

(*a*) Computation of rectangular co-ordinates on the Secant, Conical, and Bonne's projections.
(*b*) Deduction of telegraphic longitude of four stations in China.
(*c*) Reduction of Lushai Triangulation for No. 14 Party.
(*d*) Computation of places of circumpolar stars from William's College catalogue and Greenwich 10-year and 9-year catalogues.
(*e*) Computation of azimuths at three stations observed by No. 23 Party.
(*f*) Computation of stars' places for latitude observations of 1898-99 for No. 22 Party.
(*g*) Reduction of observations to determine the value of the Bubble tester.
(*h*) Re-computation of observations of the Dehra Dún Experimental Base Line.

Class 5.—Preparation of Press Copy.—This requires the abstracting and entering in suitable tables of the final results of several calculations for publication, all these compilations are twice compared, once against the original field records and once against the final computations, prior to being sent to the press. The details of the work done are as follows:—

(*a*) *Great Arc Meridional Series, Section 8° to 18°.*—Revision of orthography and compilation of descriptions of stations of the appendix finished, and the preface written out.

(*b*) *Great Arc Meridional Series, Section 18° to 24°.*—Correction of certain secondary triangles and azimuth table on account of Narsula and Chittial stations being found to be identical, and revision of descriptions of principal stations being proceeded with.

(*c*) *Net-work Triangulation of Country round Dehra Dún for the Training School.*—Orthography of names of stations corrected for letter-press.

CLASS 6.—EXAMINATION OF PRESS PROOFS.—This requires the utmost care and attention in comparison and examination in several stages of first, second, and form proofs. Most of the matter printed is numerical, or depending on numerical data; hence it necessarily involves a strictly critical examination which can only be given by men specially trained to this style of work. The printing of the following has been proceeded with:—

(*a*) The Solar Eclipse Report has been completed and issued.

(*b*) Seventy-six pages of the Tidal volume have been printed, and the volume is almost completed.

(*c*) Synoptical volumes of Great Arc Meridional Series, Section 8° to 18°, and Indus Delta Triangulation have been completed. These only want the charts on the completion of which they will be put in the hands of the binder.

(*d*) Five pages of Professional Papers No. 1, "On the projection for a Map of India and adjacent countries on the scale of 1: 1,000,000," and 32 pages of No. 2, which is a translation of M. Jäderin's "Method of measuring Geodetic Bases by means of Metallic Wires," were printed.

In addition to the above, a large amount of work was done in printing the letter-press for charts, headings and foot-notes for maps, and about 45,000 copies of professional and other forms were printed. The total amount of work executed will be seen by reference to the tabular statement of the Printing Section.

CLASS 7.—EXAMINATION OF CHARTS.—The examination of the corrections of the four final charts of the Great Arc Meridional Series, Section 8° to 18°, has been finished, and that of the rays against the azimuth list is being proceeded with.

CLASS 8.—PROTECTION OF STATIONS.—The usual professional work in connection with the protection of survey stations in India and Burma, and certain of the bench-marks in the North-Western Provinces and Bengal was performed. During the year 535 stations have been repaired by the District Officers at a cost of R2,234-4-10. Two districts out of 347, from which reports are generally received, failed to submit them.

CLASS. 9—MISCELLANEOUS.—In this are included various duties which cannot be fairly assigned to any of the other classes such as the following:—

(*a*) The examination and despatch of the printed papers to the Survey of India Office, Calcutta, for safe custody.

(*b*) The examination of all bound volumes and pamphlets prior to issue, and the preparation of the distribution lists and presentation labels for the same.

(*c*) The preparation of examination papers for the Provincial Service of the Survey of India Department, of which 32 sets were prepared, despatched, and examined, the results being tabulated and submitted to the Surveyor General.

CLASS 10.—METEOROLOGY AND GENERAL SCIENCE.—As hitherto, a complete set of meteorological observations were taken daily throughout the year, and monthly and annual abstracts prepared. Monthly magnetic observations were also taken regularly throughout the year, and the results are tabulated with those taken here previously. The meteorological and magnetic results are given in the following tabular statements:—

Mean monthly Readings of Earth Thermometers.

Depth in feet of thermometer bulbs below surface of ground.	Year.	October.	November.	December.	January.	February.	March.	April.	May.	June.	July.	August.	September.
25·6	1898-99	78·30	77·86	77·58	77·00	76·28	75·36	74·62	74·31	74·33	75·21	76·12	76·60
	Mean, 1881—98	76·83	76·88	76·70	76·14	75·61	75·00	74·43	74·13	74·08	74·41	75·67	76·69
12·8	1898-99	79·53	78·73	76·98	74·67	72·52	71·29	71·88	73·52	75·56	78·21	79·18	79·42
	Mean, 1881—98	79·44	78·12	75·96	73·41	71·70	70·81	71·37	73·18	75·28	77·27	79·18	79·71
6·4	1898-99	79·35	75·85	71·34	66·62	65·26	67·44	72·67	78·19	82·06	81·69	82·37	82·34
	Mean, 1881—98	79·75	75·91	71·31	67·36	65·66	67·12	71·59	76·89	80·32	81·38	81·46	81·18
3·2	1898-99	78·58	71·33	65·73	60·48	62·09	68·50	76·77	84·05	86·17	82·47	84·17	83·78
	Mean, 1881—98	78·27	71·88	65·68	62·04	61·37	66·73	75·65	82·24	84·79	83·40	82·06	81·68
1·1	1898-99	77·22	66·50	59·80	54·92	60·54	70·11	78·90	88·34	88·56	82·87	85·13	83·14
	Mean, 1881—98	76·31	67·81	60·21	57·51	58·72	67·63	78·88	86·17	87·88	84·18	82·29	81·57
Thermometer in shade	1898-99	80·59	72·52	64·64	62·09	68·69	82·39	86·21	93·69	88·96	81·11	84·38	86·18
	Mean, 1881—98	80·59	73·38	67·63	64·39	66·86	78·59	89·95	93·82	90·06	82·51	80·61	82·45

Mean velocity in miles of the winds which blew at Dehra Dún, during the twelve months of 1898-99, for each hour of the day.

Civil Hours.	October.	November.	December.	January.	February.	March.	April.	May.	June.	July.	August.	September.	Mean.
0 to 1	1·10	2·08	1·39	1·11	1·36	1·90	1·97	1·41	1·25	0·72	1·07	2·37	1·48
1 „ 2	1·00	1·62	1·07	1·26	1·61	1·83	1·17	1·24	1·71	0·62	0·97	1·83	1·33
2 „ 3	0·90	1·31	1·00	0·74	1·04	1·20	1·03	0·79	1·57	0·86	0·77	1·37	1·05
3 „ 4	0·80	1·08	0·68	0·48	1·61	1·43	1·34	1·00	1·25	1·00	0·70	1·27	1·05
4 „ 5	0·80	0·73	0·93	0·63	1·46	1·20	1·31	0·83	0·96	0·90	0·60	1·23	0·96
5 „ 6	0·53	0·62	0·79	0·67	1·00	1·20	0·83	0·93	0·61	0·72	0·60	1·00	0·79
6 „ 7	0·37	0·54	0·93	0·48	0·89	1·10	1·31	0·52	0·89	0·79	0·57	0·90	0·77
7 „ 8	0·27	0·54	0·61	0·78	0·79	0·90	0·97	0·79	1·00	0·93	0·60	0·47	0·78
8 „ 9	0·23	0·38	0·96	0·56	1·04	0·97	2·10	1·33	1·21	1·21	1·37	0·57	0·99
9 „ 10	0·47	0·73	1·00	0·89	1·68	1·40	1·80	2·04	1·67	1·62	1·73	0·90	1·33
10 „ 11	1·13	1·27	1·34	1·56	2·00	1·87	2·47	2·39	2·37	2·47	1·97	1·40	1·85
11 „ 12	1·65	1·92	1·97	1·78	2·36	2·33	3·27	2·57	2·48	2·40	2·10	1·87	2·22
12 „ 13	1·50	1·77	1·83	2·39	2·61	3·17	4·23	2·78	2·59	1·94	2·29	1·77	2·41
13 „ 14	1·67	2·15	2·00	2·21	3·11	3·52	4·27	3·25	3·00	2·48	2·61	2·27	2·71
14 „ 15	1·87	2·42	1·79	1·93	3·25	3·35	4·37	3·43	3·00	2·74	2·48	2·33	2·74
15 „ 16	1·60	1·62	1·28	2·11	4·04	3·27	4·21	3·86	3·50	2·42	2·03	1·23	2·59
16 „ 17	0·67	0·92	0·69	2·04	3·29	2·90	3·90	3·90	3·36	2·07	2·10	0·47	2·19
17 „ 18	0·20	0·38	0·55	0·89	1·68	1·77	2·59	2·83	2·64	1·76	1·53	0·07	1·41
18 „ 19	0·60	1·00	0·50	0·39	0·71	0·83	2·24	1·34	1·25	1·48	1·00	0·50	0·99
19 „ 20	1·03	1·85	0·50	0·46	1·39	0·97	1·48	1·34	0·96	0·79	0·93	1·37	1·09
20 „ 21	1·17	2·35	0·96	0·93	1·43	1·57	2·24	1·17	1·50	0·62	0·57	1·90	1·37
21 „ 22	1·37	2·54	1·18	1·29	1·68	1·97	2·34	1·79	1·25	0·69	0·93	2·17	1·60
22 „ 23	1·40	2·46	0·93	1·39	1·43	1·73	2·97	1·76	1·00	0·52	0·77	2·23	1·55
23 „ 24	1·47	2·08	0·81	1·18	1·57	1·63	2·14	1·31	1·07	0·69	1·30	2·10	1·45
Sums	23·80	34·36	25·69	28·15	43·03	44·01	56·65	44·60	42·09	32·44	31·59	33·59	
Average	0·99	1·43	1·07	1·17	1·79	1·83	2·36	1·86	1·75	1·35	1·32	1·40	

Monthly Meteorological Results of observations taken at the office of the Trigonometrical Branch, Survey of India, Dehra Dún.

Year and month.	Barometer reduced to 32° Fah.						Hygrometer.		Thermometer.				Rain.		Wind.	Cloud.	
	At 10 A.M.			At 4 P.M.			10 A.M.	4 P.M.	Dry Bulb.			Wet Bulb.					
	Highest.	Lowest.	Monthly mean.	Highest.	Lowest.	Monthly mean.	Monthly mean humidity.	Monthly mean humidity.	Highest maximum in air.	Lowest minimum in air.	Monthly mean in air	Lowest minimum.	No. of days it fell.	Fall in inches.	Most frequent direction.	At 10 A.M.	At 4 P.M.
1898.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	°	°	°	°	°	°					
October	27·771	27·558	27·692	27·713	27·490	27·601	50	47	86·5	52·7	70·3	49·0	...	...	Calm & S.E.	0·2	1·7
November	·875	·587	·770	·776	·509	·676	48	43	79·8	46·8	60·9	43·0	3	1·01	S.W. & Calm.	0·5	0·6
December	·872	·669	·785	·793	·589	·696	62	58	77·5	42·1	54·7	39·2	7	3·26	W. & Calm.	4·9	6·0
1899.																	
January	·857	·658	·783	·821	·588	·700	59	43	71·6	35·1	51·1	33·3	4	0·50	S. & W.	3·3	4·9
February	·870	·546	·701	·808	·490	·618	55	41	75·6	38·9	58·1	35·8	3	2·52	S. W. & W.	3·2	3·8
March	·849	·516	·677	·748	·392	·579	37	26	93·6	47·2	69·4	41·3	3	0·09	W. & S.W.	2·2	2·7
April	·681	·498	·597	·559	·398	·490	29	21	97·0	51·7	75·3	49·1	6	0·70	W.&S.W.	2·5	3·6
May	·688	·299	·485	·517	·206	·382	43	34	103·8	66·3	83·5	55·7	8	2·25	W. & E.	1·8	2·7
June	·471	·289	·394	·362	·219	·303	58	52	104·6	64·6	84·7	56·1	15	14·20	W. & N.	5·4	4·6
July	·587	·237	·373	·492	·191	·308	85	83	88·0	68·4	77·4	66·4	30	31·88	S. S. E. & W.	7·2	8·0
August	·549	·335	·437	·441	·278	·363	76	72	91·5	69·1	78·6	63·7	14	7·19	N.&N.W.	4·4	5·1
September	·674	·448	·571	·612	·354	·483	59	53	90·9	62·5	77·2	56·6	3	1·10	N. W. & Calm.	1·0	1·3

[illegible] of the results of the monthly magnetic observations taken at the Trigonometrical Branch Office, Dehra Dún. The measures of Intensity are all expressed in C. G. S. units.

Year and Month.	Magnetic Elements.				Remarks.
	Declination East.	Horizontal Intensity.	Dip North.	Total Intensity.	
	° ′ ″		° ′		
1869.					
January	...	0·33,643	41 32·2	0·44,946	With unifilar magnetometer No. 16 and Dip Circle No. 43.
February	...	·33,636	31·3	·44,925	
March	...	·33,621	28·1	·44,868	
September	3 5 10	·33,466	35·4	·44,746	
November	6 44	·33,644	32·1	·44,946	
1897.					
January	2 49 39	0·33,659	42 40·2	0·45,778	
February	48 42	·33,730	42·1	·45,898	
April	48 17	·31,901*	41·0	·43,396*	
May	50 4	·33,667	46·5	·45,866	
June	48 15	·34,032	50·5	·46,413	
July	48 42	·33,646	38·8	·45,743	
August	45 22*	·33,656	45·6	·45,840	
September	48 10	·33,695	45·2	·45,888	
October	49 27	·33,639	46·2	·45,824	
November	50 33	·33,627	44·4	·45,786	
December	48 24	·33,667	48·0	·45,884	
1898.					
January	2 50 45	0·33,757	42 48·0	0·46,007	
February	50 1	·33,605	48·2	·45,802	
March	51 12	·33,665	46·8	·45,867	
April	50 32	·33,660	52·9	·45,936	With unifilar magnetometer No. 19 and Dip Circle No. 42.
May	51 11	·33,842	51·9	·46,173	
June	51 14	·33,544	48·3	·45,721	
July	54 24	·33,271	52·1	·45,396	
August	48 24	·33,714	48·5	·45,955	
September	51 32	·33,569	52·8	·45,811	
October	49 30	·33,589	52·9	·45,839	
November	48 37	·33,389	47·9	·45,505	
December	51 14	·33,673	51·6	·45,938	
1899.					
January	2 50 24	0·33,640	42 51·0	0·45,884	
February	50 23	·33,617	51·9	·45,864	
March	50 28	·33,700	52·1	·45,981	
April	51 10	·33,616	52·1	·45,865	
May	48 41	·33,801	54·7	·46,150	
June	48 55	·32,821	49·4	·44,748	
July	50 14	·33,742	52·6	·46,044	
August	48 46	·33,786	53·0	·46,109	
September	47 51	·33,566	53·5	·45,815	

* Observations unsatisfactory.

TYPE-PRINTING SECTION.—As will be seen from the annexed statement the [illegible] part of the work done consisted in setting up the large amount of headings, foot-notes, &c., required in the Drawing Section in connection with the publication of maps, and miscellaneous work :—

Statement of work done during 1898-99.

SPECIFICATION OF PRINT.	No. of pages.	Total No. of pulls.	No. of copies of each page.	Value.
				£
Professional volume	76	10,750	500	2,447
Synoptical volumes	47	6,390	350	1,230
Letter-press for charts, map headings, foot-notes	352	8,000	...	4,017
Pamphlet of Spirit-levelled heights	24	1,390	350	622
Forms	194	96,710	...	5,217
Miscellaneous	95	12,630	...	1,039
Eclipse Report	25	2,330	200	265
Professional Papers	37	840	60	240
Extra-departmental	274	7,280	...	114
	1,124*	146,920		15,191

* Equal to 1,332 pages of Standard (foolscap) size.

The usual table showing the work annually performed by this section during the past five years is given below, the unit (a page of foolscap) being the same throughout :—

	1894-95.	1895-96.	1896-97.	1897-98.	1898-99.
Pages composed	1,219	1,135	1,110	1,597	1,332

An analysis of the pages composed in 1898-99 is as follows :—

PROFESSIONAL VOLUME	Tidal volume	152
SYNOPTICAL VOLUMES	Great Arc Meridional Series, Section 8° to 18° and Indus Delta Triangulation	94
MISCELLANEOUS	Letter-press for charts, map headings, foot-notes,	295
	Forms, Order's memoranda, &c	378
	Miscellaneous	94
	Extra-departmental	208
	Eclipse Report	35
	Professional Papers	52
	Pamphlet of Spirit-levelled heights	24
	TOTAL	1,332

PHOTO. ZINCOGRAPHIC SECTION :—The usual routine of map publication was carried on. The work is well up to date.

The following tables exhibit the value and outturn of the work of this section :—

Abstract of departmental work done during the year 1898-99.

SPECIFICATION.	Sheets or subjects.	Negatives and transparencies.	PHOTO.-ZINCOGRAPHIC PRINTING.							SILVER AND OTHER PRINTING.		Value.
			Photo-transfer prints.	Zinc plates transferred.	Zinc plates printed.	Pulls.	Number of copies. Coloured.	Uncoloured.	Total.	Silver prints.	Blue and other prints.	
												£ s.
Standard maps	160	306	278	106	126	10,322	616	9,094	9,710	17	108	6,981 11
Index maps	11	5	12	8	29	3,690	1,185	105	1,290	...	...	269 5
Technical charts	79	139	138	74	74	3,324	...	3,324	3,324	...	2	2,531 11
Miscellaneous maps, plans, etc.	266	51	116	47	297	7,788	106	15,814	15,920	6	2	2,472 6
Departmental forms	7	7	19	6	7	1,896	...	1,773	1,773	...	...	350 14
Transfers and proofs	...	...	...	...	...	964	...	...	...	...	...	...
TOTALS	523	506	563	241	533	27,984	1,907	30,110	32,017	23	112	12,605 15

Statement of work done for other departments, &c., during the year 1898-99.

Departments, etc.	Sheets or subjects.	Negatives and transparencies.	Photo-zincographic Printing.							Silver and other Printing.		Value.
			Photo-transfer prints.	Zinc plates transferred.	Zinc plates printed.	Pulls.	Number of copies. Coloured.	Uncoloured.	Total.	Silver prints.	Blue and other prints.	
												R. a.
Forest Survey	228	357	372	245	248	30,028	3,365	20,438	23,803	...	104	10,878 11
Military Department	6	6	2	2	3	107	...	57	57	...	50	19 2
Other Departments, etc.	7	9	9	7	7	274	...	274	274	...	...	146 0
Total	241	372	383	254	258	30,409	3,365	20,769	24,134	...	154	11,043 13

Table showing the amount realized from other departments, &c., by book debit and cash sales during 1898-99.

Departments, etc.	By book debit.		By cash sales.		Total.	
	R.	a.	R.	a.	R.	a.
Forest Department	536	11	240	12	777	7
Forest Survey	10,757	5	305	8	11,062	13
Quarter Master General	64	12	151	1	215	13
Military Department	...		99	2	99	2
Other Departments	858	13	585	15	1,444	12
Private Individuals	...		309	4	309	4
Total	12,217	9	1,691	10	13,909	3

Correspondence Section.—The work in this section has been carried on as usual.

Stores, Workshops, and Observatories Section.—A series of observations were taken with Zenith Sector No. 2 to determine the value of the screw of Bubble tester No. 2; and the instruments of the Base Line apparatus were examined and cleaned. In the Observatories, the usual time observations were taken, the chronometers rated and kept in order and other miscellaneous work done.

Solar Photographic Section.—The work of this section was conducted as usual. The results obtained with dry plates have been so successful as to lead to a large substitution of them for the old wet process, and in time it is expected that they will entirely supersede the wet plates.

The details of the work of this section are given below :—

Table showing the number and character of negatives.

1898-99.	Number of days.				Number of Negatives.										Number of working days when Phenomena were	
	When negatives were taken.	Failures			Solar Phenomena.								Total.			
		From bad weather.	From various causes.	Total.	Spots and faculæ.		Spots only.		Faculæ only.		None.				Visible.	Absent.
					8″	12″	8″	12″	8″	12″	8″	12″	8″	12″		
October	31	...	...	31	52	4	...	...	4	...	...	...	56	4	31	...
November	29	1	...	30	53	1	...	...	...	...	...	...	53	1	29	...
December	24	7	...	31	32	1	...	...	11	...	...	...	43	1	24	...
January	28	3	...	31	47	...	...	...	4	...	...	...	51	...	28	...
February	26	2	...	28	28	...	..	...	19	...	...	...	47	...	26	...
March	29	2	...	31	43	...	...	...	9	...	...	...	52	...	29	...
April	29	1	...	30	52	6	...	...	...	...	...	...	52	6	23	...
May	29	2	...	31	36	...	...	...	16	..	...	...	52	...	29	...
June	21	9	...	30	32	...	...	...	5	...	...	...	37	...	21	...
July	19	12	...	31	27	...	...	...	5	...	...	...	32	...	19	...
August	26	5	...	31	3	...	...	...	45	...	...	...	48	...	26	...
September	30	...	...	30	23	...	...	...	33	...	...	...	56	...	30	...
Total	321	44	...	365	428	12	...	...	151	...	...	...	579	12	321	...

Five hundred and sixteen silver prints of the 8-inch pictures, and eleven of the 12-inch pictures were prepared, and weekly despatches of both silver prints and negatives made as usual to the India Office.

Table showing the visibility of Sun at Dehra Dún and Greenwich.

Year.	At Dehra Dún.			At Greenwich.		Remarks.
	Number of days on which negatives were taken.	Percentage of days on which negatives showed features.	Number of days on which sun was invisible.	Year.	Number of days on which negatives were taken.	
1880-81*	307	96	55	1880	156	* From 1st October to 30th September following.
1881-82	328	100	37	1881	181	
1882-83	318	100	47	1882	221	
1883-84	285	100	78	1883	215	
1884-85	284	100	81	1884	154	
1885-86	290	100	75	1885	206	
1886-87	302	91	61	1886	199	
1887-88	328	71	38	1887	168	
1888-89	315	78	50	1887-88	205	
1889-90	320	99	45	1888-89	182	
1890-91	313	100	62	1889-90	212	
1891-92	304	100	62	1890-91	224	
1892-93	292	100	73	1891-92	219	
1893-94	304	100	61	1892-93	220	
1894-95	313	100	52	1893-94	230	
1895-96	324	100	41	1894-95	199	
1896-97	316	100	49	1895-96	229	
1897-98	325	100	40	1896-97†	222	† Year ending 10th May 189., obtained from the report to the Board of Visitors.
1898-99	321	100	44	1897-98	Not obtainable.	
Mean	309	...	55	...	203	

he details of the work of this section are given below:—

showing the work performed during 1898-99.

MAP.	Number of Sheets.	Scale.	REMARKS.
rd Maps.		In. M.	
sheets Nos. 264 N. E., 4 S. W., 308 N. W., and	20	1=1	Corrections completed for reduction to half scale. Final press order given.
vey sheets Nos. 247 N. E., E., 306 N. W., 307 S. W., W., and 313 S. W.	24	1=½	Corrections for reduction to half scale. In hand.
Sind Survey sheets Nos. 18, 19, 19A, and 37 (in one); 20, 33, 34, 35, 37A, 38, 48, 49, 57, 57A, 69, 77, 77A, 95, 95A, 88, 89, 106, and 107	88	1=1	For reduction to half scale. Completed headings and footnotes. Final press order given.
Sind Survey sheets Nos. 47 and 68	8	1=1	For reduction to half scale. In hand.
Sind Survey sheets Nos. 19, 19 A, and 37 (in one); 20, 20A, 37A, 38, 57, 57A, 77, 77A, 95, and 95A.	48	2=1	For re-production. Completed headings and footnotes, for other Department.
Gujarát Survey sheet No. 7.	4	1=1	Touched up for photography.
Plans of Cities and Cantonments.			
Cantonment of His Excellency The Viceroy's Body Guard, Dehra Dún, 1898	1	20=1	Completed. Final press order given.
Index Maps.			
Triangulation Chart of India	1	1=96	Corrected and brought up to date for Annual Report.
Index to the Map of India and adjacent countries	1	1=128	Compilation in hand. For reduction to half scale.
Index to illustrate survey operations by No. 18 Party in the Himálayas.	1	1=20	Corrected and brought up to date for Annual Report.
Index to illustrate survey operations by Nos. 12 and 15 Parties in Sind.	1	1=50	Ditto ditto.
Diagram of Group of Astronomical Latitudes and Azimuths round Kaliánpur H. S.	1	1=16	Prepared for Annual Report.
Charts.			
Triangulation Chart of Great Arc Series, Section 8° to 18°	4	1=4	In hand.
Nos. 43 and 44, Preliminary Charts of Indus Delta Coast Triangulation	2	1=4	Do.
Preliminary Chart of Assam Longitudinal Series, 1853-55	1	1=4	Corrections completed. Final press order given.
Charts of Triangulation sheets Nos. 8, 9, 10, 11, 12, 13, 14, 15, 17, 18, 19, 20, 23, 24, 25, 26, 27, 28, 34, 35, 36, 37, 38, 39, 63, 64, 82, 83, and 84 (Central Provinces)	29	1=2	For reduction to half scale. Completed headings and footnotes. Final press order given.
Charts of Triangulation sheets Nos. 311 (2nd edition) and 332 (Punjab)	2	1=2	Ditto ditto.
Charts of Triangulation and Traverse sheets Nos. 15, 32, 33, 34, 37, 37A., 38, 49, 50, 57A., 66, 67, 68, 69, 70, 77, 77A., 86, 87, 90, 91, 95, 95A., 105, 106, 107, 108, and 109. (Sind)	28	1=2	Ditto ditto.
t of Triangulation sheet No. 16 nd)	1	1=2	Ditto ditto.
Traverse sheets Nos. 19, 20, 47, 88, and 89 (Sind)	7	1=2	Ditto ditto.
arts Nos. 67 and 74	2	1=2	Compilation in hand.
ion Chart of Dehra Dún Sur-	1	1=½	In hand.

Statement showing the work performed during 18

Title of Map.	Number of Sheets.	Scale.	
Miscellaneous.			
Tidal Maps of Coconada, Chittagong, Akyab, Elephant Point, Moulmein and Mergui.	6	Various	Completed. Final press order given.
Tidal Maps of Bhávnagar, Bombay, Mormugáo, Vizagapatam, and Kidderpore.	5	Various	In hand.
Tidal Curves of Aden, Karáchi, Okha Point, Port Albert Victor, Bhávnagar, Bombay (Apollo Bandar), Bombay (Prince's Dock), Kárwár, False Point, Dublat, Diamond Harbour, Chittagong, Akyab, Rangoon, Amherst, Moulmein, Mergui, and Port Blair	18	Various	Completed. Final press order given.
Tidal Curves of Mormugáo, Beypore, Cochin, Tuticorin, Minicoy, Galle, Colombo, Trincomalee, Pámban Pass, Negapatam, Madras, Coconada, Vizagapatam, Kidderpore, Elephant Point, and Hanstal Point	16	Various	In hand.
Special Survey of the Mahásu Range, Simla extension	2	In. M. 6=1	Touched up for photography. Final press order given.
Other Maps	9	Various	Touched up for photography and completed as regards headings and footnotes. Final press order given.
Maps coloured	1,812	Various	

Maps Examined.

Standard original maps	165
Charts	68
Miscellaneous maps	35
Photographic proofs of Standard sheets and other maps	280
Total	548

N.B.—In addition to the above other miscellaneous duties have been performed, such as correcting and completing the Standard sheets and Triangulation Charts of the Central Provinces, Punjab, and Sind Surveys in respect of headings, footnotes, symbols, etc., for press; taking out and checking areas of villages with their cultivation in the Punjab Survey sheets and incorporating the Indus Riverain Survey on the Sind Survey sheets; examination of and custody of records, making all the despatches of maps, etc., etc., etc.

Statement of work done for other departments during 1898-99.

Title of Map.	Number of Sheets.	Scale.	Remarks.
Standard Maps.		In. M.	
Forest Surveys	169	4=1	Completed headings, footnotes, and references. Final press order given for Forest Department.
Index Maps.			
Forest Surveys	5	Various	Ditto ditto.
Miscellaneous.			
Forest Surveys	29	Various	Ditto ditto

SURVEY BRANCH OFFICE, DEHRA DÚN.

...ing the progress made in map drawing during the year.

	Province.	No. of sheets: Published during the year.	In the Press.	In different stages of progress.	Remarks.
...maps on various scales, chiefly Forest Working-plans purposes	North-Western Provinces and Oudh	3	...	...	
	Central Provinces	...	...	1	
	Berar	1	...	1	
	Coorg	1	...	...	
Other special maps on various scales for use of Forest Department	North-Western Provinces and Oudh	...	1	...	
	Bengal	...	1	...	
	Assam	...	1	...	
	Punjab	7	...	4	
	Central Provinces	...	1	1	
	Berar	6	17	...	
	Ajmer-Merwára	1	...	...	
	Coorg	...	1	...	
	Balúchistán	1	...	...	
	Andamans	1	...	...	
	Burma	1	...	...	
	Madras	...	1	...	
	India	1	9	...	
	Miscellaneous	11	...	...	
4-inch standard sheets of Forest tracts surveyed by the Forest Surveys, Bengal Presidency	North-Western Provinces and Oudh	27	...	46	
	Punjab	9	2	29	
	Central Provinces	129	45	163	
	Burma	17	36(*a*)	34(*b*)	(*a*) Includes 35 sheets of No. 20 Party. (*b*) 3 on 2-inch.
1-inch standard sheets of Forest tracts surveyed by the Forest Surveys, Bengal Presidency	Punjab	...	...	7	
	TOTAL	216	115	286	

G. I. C. P. O.—No. 18 S. G.—28-5-1900.—450.

1900.

GOVERNMENT OF INDIA.

DEPARTMENT OF REVENUE AND AGRICULTURE.

Code No. 96 of 1900.

Serial No. 2.

LAND-SURVEYS.

RESOLUTION.

No 1—96-2.

Dated Simla, the 10th July 1900.

SUBJECT.

Reviews the General Report on the operations of the Survey of India Department for the year 1898-1899.

G. C. Press, Simla.—No. 546 R. & A. D.—13-7-1900.—660.

No. 1—96-2.

Extracts from the Proceedings of the Government of India, Department of Revenue and Agriculture, No. 1—96-2, dated Simla, the 10th July 1900.

READ—

The General Report on the operations of the Survey of India Department during the year 1898-99.

RESOLUTION.

During the year ending the 30th September 1899, the field operations of the Survey of India Department were carried on by two double and seventeen ordinary parties.

The various classes of work on which these parties were engaged are shown below :—

	No. of parties employed.	No. of detachments employed.
Trigonometrical	1	
Topographical	8	
Forests	3 (1 double).	
Cadastral	2	
Traverse	2 (1 double).	1
Scientific	3	
TOTAL ...	19	1

2. The total area surveyed on all scales during the year was 95,934 square miles against 36,199 square miles in 1897-98. The increase is due to the large amount of reconnaissance executed in Yunnan and along the Burma-China boundary.

3. Trigonometrical operations were, as in the previous year, carried on by one party only. As conditions in Makrán were still unfavourable, the opportunity was taken to complete the Manipur Longitudinal Series and to link up the Burma Triangulation with the other Principal Triangulation in India. The angles at some of the stations of season 1894-95 were reobserved, and the results proved that no displacement in that part of Assam had been caused by the great earthquake of 1897.

4. Eight parties as against seven in the previous year were employed on topographical surveys in the Shan States, Upper and Lower Burma, Sindh, the Lushai Hills and the Himalayas. The following are the most noticeable items of work—the beginning of a large scale survey of the station of Maymyo, the complete survey of the town and cantonment of Nahan at the expense of the State,

surveys connected with military requirements in the Rawalpindi District and in Kashmir, and a special survey of the coal bearing area on the Sor Range near Quetta. The area topographically surveyed amounted to 18,280 square miles against 15,109 square miles in the previous year.

5. Forest surveys were continued by Imperial Survey parties in Madras, Bombay, Burma and part of the Himalayas and by the Forest Survey branch in the Central Provinces, Punjab and Burma. In Madras the amalgamtion and reorganization of two parties under a single Imperial Officer resulted i a large increase of outturn, 1,350 square miles being surveyed on the 4-inch scal. A total area of 738 square miles was surveyed in Bombay on three different scales. In Lower Burma No. 20 Party carried on operations in the Pegu, Shwegin, Thayetmyo and Rangoon Forest divisions in the face of considerable diffiulties, due to the wild and inhospitable nature of the country. An area of 559 square miles was surveyed, while 1,200 square miles of triangulation and 186 square miles of traversing were completed. The outturn of work for the past two years executed by the Imperial Parties and the Forest Survey Branch is given below :—

	1897-98.	1898-99.
Imperial Parties	2,397	2,960
Forest Survey Branch	1,737	2,257
Total ...	4,134	5,217

The cost rate in Madras was greatly reduced, being Rs. 4 per square mile, and was the lowest since work was begun in that Presidency. In Bombay also the cost rates were satisfactory, and the same may be said of rates in Burma, those for detail survey and triangulation being the lowest hitherto recorded by No. 20 Party.

6. Cadastral operations were carried on by one party in Burma, one in Bengal and one in the North-Western Provinces, the two latter being under the control of Local Governments. The Burma party completed an area of 711 square miles in the Toungoo District and 109 square miles in the Myingyan District. In Bengal 607 square miles were completed in Saran and 684 square miles in Darbhanga, while large areas were traversed in Saran, Darbhanga, Champaran and the Sonthal Parganas. In addition the towns of Darbhanga and Chapra were traversed and surveyed, and some minor miscellaneous work, topographical and traverse, was carried out in the Districts of Champaran and Shahabad, and in the Kachnar and Banskati *mahals* and on the Nepal Frontier in connection with the rectification of boundaries. In the North-Western Provinces the cadastral survey of the Districts of Bareilly and Kheri and of the hill parganas of Naini Tal was completed. The total area surveyed in the different provinces amounted to 5,554 square miles against 6,976 in the preceding year, the figures for the three provinces being as follows :—

	1897-98.	1898-99.
Bengal	1,300	1,420
Burma	2,236	820
North-Western Provinces and Oudh ...	3,440	3,314
	6,976	5,554

The decrease in the total as compared with the previous year is due to a reduction of the annual outturn in Burma to about 800 square miles with a view to preventing the survey getting too far ahead of the revenue settlement operations.

7. Traverse operations were executed by one double party in the North-Western Provinces and Oudh, one single party in Assam and a detachment in the Central Provinces. The total area traversed in the three Provinces during the year was 5,354 square miles, an increase of 226 square miles on the outturn of 1897-98.

8. Latitude observations were continued by the two astronomical parties with results that promise in the case of No. 22 Party, which worked on the East Coast, to be of considerable interest in connection with oceanic attraction and the deviation of the plumb line.

9. Tidal observations with self-registering tide-gauges were continued at 13 stations in India, Burma, the Andaman Islands, the Persian Gulf and the Red Sea, while a series of personal tidal observations to graduated staves was continued at 6 stations with the object of comparing the actual times and heights of high and low water with those predicted in the tide tables. The observations at Diamond Island were completed. The further investigation of meteorological conditions prevailing in the Persian Gulf conclusively proved that wind produces a considerable effect on tides in the Gulf. Spirit levelling operations were continued from Katni to Allahabad and from Katni to Kethora and from thence to the two ends of the Sironj Base line, giving a total outturn of 378¼ miles of double levelling.

10. In Kashmir and Gilgit 2,043 square miles were geographically surveyed, while geographical reconnaissance on the ¼ inch scale was carried out over no less than 65,000 square miles on the frontiers.

11. In the various head-quarters offices the progress of work has been satisfactory. The Drawing Office was occupied with completing and keeping up to date the maps of the North-Eastern and South-Eastern Frontiers. The 3rd edition of the 32-mile map of India has been published, and a new Railway map of India on the same scale is in course of publication. Eighteen sheets of the Town of Calcutta on the scale of 1″=50 feet were revised and tested by a Provincial Officer during the year under a scheme sanctioned by the Government of Bengal. A series of maps was also prepared to illustrate Mr. Grierson's work in connection with the Linguistic Survey of India, and 4,609 cadastral sheets were published during the year.

12. The Engraving Office made steady progress in the publication of the quarter sheets of the Atlas of India. Additions and corrections were made to the 16-mile provincial maps of Madras, Bombay, Bengal, Central Provinces, Central India, Rajputana and Gujrat. Thirteen district maps for administration reports have been completed and published, while others together with Index maps, charts, imprint and note plates were in hand for correction. The process of correction of copper plates by cutting out the face and refilling by electro-deposited copper, which was first devised in the Engraving Office, has apparently given excellent results.

13. A large increase in the amount of work sent in by other Departments and Government officials was successfully dealt with in the Photographic and Lithographic Office. The number of original subjects disposed of during the year was 6,873 as against 6,364 in 1897-98. The printed outturn, excluding type work, amounted to 965,453 against 695,812 in the previous year. This increase was due to the fact that the outturn consisted of Burma and Assam sheets, of which more copies were required than of the North-Western Provinces sheets which formed the bulk of last year's outturn. The total value of the work done was Rs. 2,17,622, an increase of Rs. 24,696 over the value of the outturn of 1897-98.

14. The total number of maps issued from the Map Record and Issue Office amounted to Rs. 1,94,848 and their value Rs. 2,15,195, an increase on the figures of the previous year of 38,325 and Rs. 97,253 respectively.

15. In the Mathematical Instrument Office, the total number of instruments issued was 72,514 and their value Rs. 2,59,435 against 59,100 and Rs. 2,83,857 for 1897-98. There was a slight increase in the value, though a decrease in the number, of instruments taken from the repairable stock and rendered serviceable. The conversion of old pattern levels and theodolites was steadily continued. There was, however, a slight increase in the value of instruments indented for from England, owing to the necessity for replenishing the stock of more expensive instruments, the figures for 1898-99 being £5,174 and for 1897-98 £4,823.

16. In the Trigonometrical Branch Office at Dehra, a good deal of heavy computation work was carried out, and the usual meteorological and solar photographic observations were continued. In the latter work the substitution of dry for wet plates promises success. The Training School continued to do

good work. Seven officers of the Imperial Service, 13 of the Provincial Service, and 15 sub-surveyors passed through appropriate courses.

17. The administration of the Department continued during the year under Major-General C. Strahan, R.E. He retired at the close of the survey year on the 30th of September 1899, the value of his services being acknowledged at the time by the Government of India. An interesting retrospect of the progress of the Department during his tenure of the office of Surveyor-General was drawn up by him and is printed on pages 13—16 of the report. The administration of the Department during the closing year of his service and the work of the officers under him was maintained at the same high standard of efficiency which it has been the pleasure of the Government of India to acknowledge in previous years.

ORDER.—Ordered that the above Resolution be forwarded to the Surveyor-General of India, the Inspector-General of Forests, the Local Governments and Administrations noted on the margin, and to the Foreign, Military and Public Works Departments.

Madras.	Burma.
Bombay.	Central Provinces.
Bengal.	Assam.
North-Western Provinces and Oudh.	Coorg.
Punjab.	Berar.

Ordered, also, that the Resolution be published in the Supplement to the *Gazette of India*.

[True Extract.]

T. W. HOLDERNESS,

Secretary to the Government of India.

Survey of India Department,

GENERAL REPORT,

1899-1900.

Agents for the sale of Books published by the Superintendent of Government Printing, India, Calcutta.

In London.

E. A. Arnold, Esq., 37, Bedford Street, Strand, W. C.

Messrs. Constable & Co., 2, Whitehall Gardens, S. W.

Messrs, Sampson, Low, Marston, & Co., St. Dunstan's House, Fetter Lane, E. C.

B. A. Quaritch, Esq., 15, Piccadilly, W, C.

Messrs. P. S. King & Son, 2 & 4, Great Smith Street, Westminster, S. W.

Messrs. Luzac & Co., 46, Great Russell Street, W. C.

Messrs. Kegan, Paul, Trench, Trübner & Co., Charing Cross Road, W. C.

Messrs. Williams and Norgate, Oxford.

Messrs. Deighton Bell & Co., Cambridge.

On the Continent.

Messrs. R. Friedlander & Sohn, 11, Carlstrasse, Berlin.

Otto Harrassowitz, Esq., Leipzig.

Martinus Nijhoff, Esq., The Hague, Holland.

Karl W. Hiersemann, Esq., Leipzig.

Ernest Leroux, Esq., 28, Rue Bonaparte, Paris.

In India.

Messrs. Thacker, Spink & Co., Calcutta and Simla.

Messrs. Newman & Co., Calcutta.

Messrs. Thacker & Co., Ld., Bombay.

E. Seymour Hade, Esq., Fort Bombay.

Messrs. Higginbotham & Co., Madras.

Superintendent, American Baptist Mission Press, Rangoon.

Rai Sahib M. Gulab Singh & Sons, Mufid-I-Am Press, Lahore.

Messrs. A. J. Combridge & Co., Bombay.

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SUNRISE ON NANGA PARBAT. (26 620 Ft)

GENERAL REPORT

ON THE

OPERATIONS

OF THE

Survey of India Department

ADMINISTERED UNDER

THE GOVERNMENT OF INDIA

DURING

1899-1900.

PREPARED UNDER THE DIRECTION OF

COLONEL ST. G. C. GORE, R.E.,

SURVEYOR-GENERAL OF INDIA.

LIBRARY OF THE BOMBAY BRANCH OF THE ROYAL ASIATIC SOCIETY

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GENERAL REPORT

ON THE

Operations of the Survey of India

DURING THE SURVEY YEAR

1899-1900.

PART I.

SUMMARY.

ADMINISTRATION.

1. The operations of the Department that are now reported on are for the survey year ending 30th September 1900.

2. Major-General C. Strahan, R.E., having retired from the department, Colonel St. G. C. Gore, R.E., succeeded him as Surveyor-General of India, from 1st October 1899. The general administration of the department and the superintendence of the Topographical Branch remained throughout the year in the hands of Colonel Gore.

Colonel J. R. Hobday, I.S.C., Deputy Surveyor-General, held charge of the Revenue Branch throughout the year except for the period from 22nd February to 22nd May 1900, when he proceeded on privilege leave, and Major F. B. Longe, R.E., officiated as Deputy Surveyor-General.

Major S. G. Burrard, R.E., succeeded to the post of Superintendent, Trigonometrical Surveys, *vice* Colonel Gore, appointed Surveyor-General; but as he was absent on deputation at Chatham at the time, Mr. J. Eccles officiated for him until his return on 12th January 1900, when he assumed charge of the Trigonometrical Branch, which he held up to the close of the year.

Captain C. W. H. Symonds, I.S.C., continued to officiate as Superintendent of Settlement Surveys, Bengal, until he proceeded on furlough on the 10th March 1900, when he was relieved by Captain A. Mears, I.S.C., who held charge of the office until the return from furlough of Major G. B. Hodgson, I.S.C., on the 7th April 1900, when the latter assumed charge and held it till the close of the year.

The office of the Superintendent, Land Records Surveys, North-Western Provinces and Oudh, was held by Mr. G. B. Scott throughout the year.

Inspection Tours of the Administrative Officers.

3. Colonel St. G. C. Gore, R.E., Surveyor-General of India, after receiving charge of the department, proceeded to Karáchi to inspect the recess office of No. 12 Party, and during his return went to Quetta in order to confer with the Agent to the Governor General on the possibility of continuing the surveys in Makrán, and subsequently visited the Trigonometrical Branch Office at Dehra Dún, returning to Calcutta on the 23rd October. On the 10th April he proceeded to Simla, visiting the Trigonometrical Branch Office at Dehra Dún *en route*. During his stay at Simla he twice inspected the office of No. 18 Party (Himalayas). He left Simla on the 17th July and arrived at Dehra Dún, where he visited the Forest Survey Office and the Trigonometrical Branch Office, and also inspected the equipment that was being got ready for the survey party that accompanied the China expedition. He proceeded to Mussooree on the 25th and inspected No. 15 Party there, and also visited No. 4 Party and the

Punjab detachment, and returned to Calcutta on the 5th August. On the 26th he again left Calcutta and proceeded to Bangalore where he inspected the recess offices of Nos. 10, 11 and 21 Parties. He also visited the recess offices of Nos. 3, 9 and 19 Parties there. On the 12th September he proceeded to Poona and inspected No. 17 Party. On the 18th he left for Simla, where he was summoned to discuss certain matters with the Revenue and Agricultural and Foreign Departments and returned to Calcutta on the 15th October 1900, again visiting the Trigonometrical Branch Office at Dehra Dún during his return.

4. Colonel J. R. Hobday, I.S.C., Deputy Surveyor-General, inspected No. 14 Party (Lushai) at Shillong in September 1899, and then proceeded the following month to Darjeeling to confer with the Bengal Government regarding the recruitment of coolies at Darjeeling and Jalpáiguri for the use of the survey party working in the Lushai Hills. In December he visited Etáwah, where he accompanied Mr. G. B. Scott, the Superintendent, Provincial Surveys, North-West Provinces and Oudh, to witness the training of *patwáris* in that district.

During January and February he inspected in the field the cadastral survey camps under the Superintendent, Settlement Surveys, Bengal, and proceeded on three months' privilege leave to England on 22nd February. During his absence Major F. B. Longe, R.E., officiated as Deputy Surveyor-General and inspected Nos. 3 and 7 Parties in Burma during the months of March and April. In May Major Longe proceeded to Mussooree to inspect the Punjab detachment, and thence to Simla to confer with the Surveyor-General.

Colonel Hobday returned from privilege leave on 23rd May and proceeded to Darjeeling on 13th June to confer with the Director of Land Records, Bengal, returning to Calcutta on 18th idem. In July he visited Jubbulpore to inspect the Central Provinces detachment, and continued on to Bangalore to inspect Nos. 3, 9 and 19 Parties. He also visited there Nos. 10 and 21 Parties. In August he proceeded to Nágpur to be present at a conference which was held to decide several questions regarding survey matters in the Central Provinces. In September he visited Naini Tal to inspect the recess offices of the North-West Provinces and Oudh Provincial Surveys and continued on the following month to Mussooree to inspect and arrange about the next field season's programmes of the Punjab detachment and No. 4 Party (Bengal). Before his return to Calcutta he also visited the office of the Superintendent, Trigonometrical Surveys at Dehra Dún.

5. Major S. G. Burrard, R.E. Superintendent, Trigonometrical Surveys, visited Mussooree in June and inspected Nos. 22, 23 and 24 Parties. In July he inspected No. 25 Party (Tidal and Levelling) and in August proceeded to Simla, where he inspected No. 18 Party (Himalaya). No. 12 Party (Sind) having been inspected by the Surveyor-General in October 1899, the Superintendent did not go to Karáchi for its inspection.

FIELD PARTIES.

6. Field operations were carried on by one double and fifteen ordinary parties and four detachments,—of these, one was employed on trigonometrical; eight on topographical surveys; one double and one ordinary party on forest surveys; two parties on cadastral surveys; four detachments on traverse surveys and three parties on scientific operations. The only differences between the parties employed during the year under report and the previous year are:—One ordinary party No. 20, employed on forest surveys in Burma was transferred to the Forest Survey Branch; and one double party Nos. 2 and 8, employed on traverse survey, was transferred to the North-West Provinces Survey. The reduction in numbers, however, by the transfers of these parties is only apparent, as they still have to be officered and manned by the Survey Department. Another traverse party, No. 6 (Assam), was replaced by a detachment. Three new detachments were formed for traverse surveys in the Central Provinces, Punjab and Sonthál Parganas.

7. The operations of the Forest Survey Branch were carried on in addition to the above and are reported on herein. The surveys carried on by local agency in the North-West Provinces and Oudh, which are under the general supervision of the Deputy Surveyor-General, have also been included in this report under the head of Cadastral Surveys.

8. In the following statement the whole of the operations are grouped according to the nature of the work on which the parties were employed :—

Statement of Survey Operations and Parties.

No. of Party.	Nature and *locale* of operations.	Page in this Report.	Executive Officers.	Scale of Survey.	Administrative Superintendent.
	Trigonometrical.			Inch Mile.	
24	India Triangulation	15	Lieutenant H. H. Turner, R.E.	.....	Supdt., Trig.
	Topographical.				
3	Lower Burma	16	Mr. E. Litchfield	1 = 1 2 = 1 8 = 1	D. S. G., Rev.
10	Upper Burma	18	Major J. M. Fleming, I.S.C. Captain F. W. Pirrie, I.S.C. Captain H. J. Hare, R.E. Mr. G. D. Cusson	1 = 1 and 16 = 1	Ditto, Topo.
11	Ditto	20	Mr. P. J. W. Doran	1 = 1	Ditto
21	Ditto	21	Captain H. J. Hare, R.E. Mr. H. Todd	1 = 1 ½ = 1	Ditto
12	Sind	23	Mr. C. F. Erskine	2 = 1 4 = 1	Supdt., Trig.
14	Lushai Hills	25	Captain C. L. Robertson, R.E. Mr. R. Waller-Senior	24 = 1 1 = 1 ½ = 1 ¼ = 1	D. S. G., Rev.
15	North-Western Frontier	26	Colonel R. A. Wahab, C.I.E., R.E.	12 = 1 6 = 1 3 = 1 1 = 1 ½ = 1 ¼ = 1 ⅛ = 1	Ditto, Topo.
18	Himalayas, Punjab	27	Major W. J. Bythell, R.E. Mr. C. D. Potter	4 = 1 2 = 1 1 = 1	Supdt., Trig.
	Forest.				
9 & 19	Madras Presidency	31	Captain A. H. B. Hume, R.E. Captain F. W. Pirrie, I.S.C. Captain H. J. Hare, R.E. Mr. H. Todd	4 = 1	D. S. G., Rev.
17	Bombay ditto	33	Captain P. J. Gordon, I.S.C. Mr. C. E. Tapsell „ S. F. Norman	16 = 1 8 = 1 4 = 1	Ditto, Topo.
	Operations of the Forest Survey Branch.	35			
	Central Provinces	46	Mr. W. H. Reynolds	4 = 1	I. G., Forests.
	Bengal	51			
	Punjab	54			
	Burma	57			
	Cadastral.				
2 & 8	North-Western Provinces and Oudh.	46	Mr. G. B. Scott	16 = 1	D. S. G., Rev.
4	Bengal	51	Captain C. W. H. Symonds, I.S.C. Lieutenant A. Mears, I.S.C. Major G. B. Hodgson, I.S.C.	16 = 1	Supdt., Settlement Surveys, Bengal.
27	Burma	54	Mr. B. G. Gilbert-Cooper „ E. G. Little	16 = 1 64 = 1 132 = 1	D. S. G., Rev.
	Traverse.				
Detachment.	Assam	57	Mr. J. H. O'Donel „ T. Shaw	.....	D. S. G., Rev.
„	Bengal Sonthal Parganas	59	„ E. F. Berkeley	.....	Supdt., Settlement Surveys, Bengal.
„	Central Provinces	62	„ W. C. Price	.....	Ditto.
„	Punjab	64	„ R. B. Smart	.....	Ditto.
	Geodetic.				
22	India	67	Lieutenant E. A. Tandy, R.E. Lieutenant H. M. Cowie, R.E.	.....	Supdt., Trig.
23	Ditto	70	Captain G. P. Lenox-Conyngham, R.E.	.....	Ditto.
	Tidal and Levelling.				
25	India	72	Lieutenant H. L. Crosthwait, R.E.	.....	Ditto.

OUTTURN.

9. The total outturn of detail survey during the year amounts to 149,677 square miles which includes 120,259 square miles of reconnaissance surveys on the $\frac{1}{4}$-inch and smaller scales. The area surveyed during the previous year amounted to 95,934 square miles, and the large increase this year is due again to large areas of reconnaissance surveys on the north-east and north-west frontiers. The total area of rigorous surveys on all scales is 29,418 square miles, which is 367 square miles in excess of that done last year. The total area triangulated is 41,110 square miles which includes 16,000 square miles triangulated in connection with reconnaissance surveys. The total area traversed for cadastral purposes is 5,850 square miles, *viz.*, 2,644 in the North-Western Provinces, 1,318 in Bengal, 816 in Burma, 978 in the Central Provinces and 94 in Assam.

TRIGONOMETRICAL SURVEYS.

10. The principal triangulation in India having been linked with the Burma triangulation last year, the triangulation party was sent in two detachments to Upper Burma, one to run a minor series southwards *viâ* the Kale and Kabaw valleys connecting the Manipur Meridional Series with the Coast Series near Akyab, and the other to carry a minor series eastwards from the Mandalay Meridional till it joined the other minor series mentioned above.

These minor series were taken up in preference to the principal series which remains to be done along the Eastern frontier, as there was an urgent need for topographical purposes of a series running through the almost unknown country which lies along the Burma-Bengal boundary.

TOPOGRAPHICAL SURVEYS.

11. The number of parties engaged on topographical surveys is the same as that of the previous year and the *locale* of their operations has been the same. Four of these, *viz.*, Nos. 3, 10, 11, and 21 continued to work in Burma: No. 3 Party in Lower and the others in Upper Burma.

The greater part of the area surveyed by No. 3 Party lay on the western slopes of the Arakan Yoma hills and was done on the 1-inch scale. The country was mostly uninhabited, covered with dense forests and devoid of roads. The outturn for the season is 3,757 square miles of triangulation and 1,837 square miles of topography in addition to 102 square miles of skeleton survey on the 4-inch scale with demarcation of the boundaries of certain blocks of land of the Yenangyat oil-field in the Pakôkku district of Upper Burma. The cost-rates, ₹ 4·8 for triangulation and ₹ 25·5 for topography, are again low for the class of country under survey, being slightly lower than those of last season. The party once more suffered a good deal in health owing to the unhealthy nature of the country.

12. The work of No. 10 Party is confined to the west of Longitude 96° 30′ and its outturn is 6,550 square miles of triangulation and 3,368 square miles of topography almost all on the 1-inch scale. The area triangulated lies in the Sagaing, Meiktila, Myingyan, Magwe and Yamèthin districts and the detail survey in the Ruby mines, Shwebo, Mandalay Kyauksé, Meiktila and Yamèthin districts. Of the detail survey 1,350 square miles consists of topography omitted when the districts were under cadastral survey. The cost-rates are ₹3·9 for triangulation and ₹20·4 for the 1-inch detail survey; the rate for triangulation being much lower while that for topography is the same as that of last season. A great part of the area triangulated lay in cultivated country where the hills required no clearing. The large scale survey of Maymyo commenced last season was completed. It covers an area of 17·8 square miles.

13. Nos. 11 and 21 Parties continued the survey of the Shan States and the aggregate area surveyed by the two parties on the 1-inch scale amounted to 3,842 square miles, 4,605 square miles of triangulation also being completed. The country under survey was similar to that of former seasons, hilly and intricate, covered with scrub jungle and unhealthy. These two parties were again called upon to supply surveyors for the Burma-China boundary survey and

other special surveys. The average cost-rate for the triangulation is R10·5 and that for the topography R19·1. That for triangulation is much the same as last year's, while for the topography it is considerably higher, owing to the fact that permanent carriage had to be kept up the whole season for the purpose of supplying the surveyors with food, and that bullock transport had to be substituted this year for carts previously used.

A large scale survey of Hsi Paw town and environs was commenced, 81 square miles being triangulated and traversed.

The result of the season's work in Burma is an addition to our topography of 9,010 square miles.

14. The topographical survey of Sind on the scale of 2 inches=1-mile was continued during the past season in the northern parts of that province. An area of 2,383 square miles was surveyed and mapped at an average cost of R10 *per* square mile. Triangulation and traversing were also carried on: under the former heading an area of 900 square miles was completed, while under the latter 2,600 linear miles of traversing was run.

In addition to the above the party also undertook and completed a special survey of the Khairpur State boundary on the scale of 4 inches=1 mile. The area covered by this was 425 square miles and the average cost R31 *per* square mile. The traversing in connection with this survey amounted to 560 linear miles.

15. The survey of the Lushai Hills was continued by No. 14 Party on the 1-inch scale and an area of 759 square miles surveyed on that scale, while the tertiary triangulation was extended over a fresh area of 787 square miles. A special survey was also carried out on the ½-inch scale of the Manipur-Lushai border which covered 44 square miles and the survey of the station of Aijal was commenced on the scale of 24 inches to the mile. The outturn of topography slightly exceeds that of last season, though the outturn of triangulation is not so large, owing to the deputation of the officer in charge and one native surveyor with a military expedition on the north-east frontier of Assam; the cost-rate of the triangulation, R 42·5, is consequently higher than last year's rate and that of the 1-inch topography, R56·4, is less. The physical difficulties of the country and the necessity of importing all supplies will always render this a costly survey. The question is under consideration whether a survey of these hill tracts on the ½-inch scale will not sufficiently meet all requirements. The reduction of scale would cheapen and quicken the survey.

16. No. 15 Party was again employed on various surveys for the Military Department in the Punjab, Secunderabad (Madras) and Kashmir. In Kashmir the regular ½-inch survey was extended in Chilás, Astor and the Kishenganga valley and the 2-inch survey was completed of the road between Chitrál and Gilghit. No detail survey was done in Sind but an area of 980 square miles was triangulated. The total outturn of the party for the season is 2,033 square miles of triangulation, 3,941 square miles of detail survey on various scales and 27,515 square miles of reconnaissance surveys.

17. No. 18 Party surveyed 964 square miles on the 2-inch scale in the Hoshiárpur and Kángra districts and the Simla Hill States; 168 square miles on the 1-inch scale in the Kángra district and the Kullu sub-division, and 108 square miles on the 4-inch scale in the Hoshiárpur and Kángra districts and the Kullu sub-division. The average costs being R49, 45 and 60 *per* square mile respectively.

A special survey of the Simla Municipality has been undertaken on the scale of 1 inch=50 feet and is in progress.

18. The total outturn for the year under the head of topographical surveys on various scales from the 1-inch upwards amounted to 14,547 square miles against 18,280 square miles completed the previous year. The total is made up as follows:—

9,963	square	miles	surveyed	on	the	1-inch	scale.	
4,159	"	"	"	"	"	2	"	"
425	"	"	"	"	"	4	"	"

FOREST SURVEYS.

19. The special surveys of Government Forests on various scales are carried out in part by the Forest Survey Branch and partly by the Survey Department. As mentioned in the report for last year, No. 20 Party, employed in the forests in Burma, has been transferred to the Forest Survey Branch, and there only remain now under the Survey Department the parties working in Bombay and Madras.

20. During the year surveys have been carried on in Madras, Bombay, Burma, the Central Provinces, Bengal and the Punjab. In Madras the double party Nos. 9 and 19 continued work as before. Detail surveys of Reserved Forests were carried on in the Kurnool, Cuddapah and Coimbatore districts, and triangulation in preparation for survey was commenced in South Kánara. In all 1,524 square miles of 4-inch survey were completed at a cost-rate of ₹58 *per* square mile.

21. In Bombay, as before, the forests have been surveyed on three different scales, according to their nature. The special teak reserves are surveyed on the 8-inch scale; the small areas of *bábul* reserves on the 16-inch scale; while the bulk of the forests are mapped as elsewhere in India on the 4-inch scale. During the year detail surveys of the teak reserves in the Thána and Násik districts and of the *bábul* reserves in the Sholápur district were carried on on the larger scales, while in the southern circle the North Kánara forests were surveyed on the 4-inch scale. The areas surveyed were—on the 4-inch scale 379 square miles; on the 8-inch scale 236 square miles; and on the 16-inch 55 square miles.

22. With the exception of the cost of traversing the cost-rates are, as might have been expected during a year of famine, higher all round than the exceptionally low rates of the previous year. A large charge for grain compensation had to be met and the area surveyed is less than might ordinarily have been expected. This party has suffered severely from the effects of plague of late years having lost many of its most efficient native surveyors, whose places it is very difficult to fill. During the season the health of the party was not good, there being much sickness among the men.

23. In Burma, No. 20 Party and the detachments which were previously working under the Superintendent, Forest Surveys, have all been combined under one executive officer. In the Tenasserim Circle surveys were carried on in the Ataran, Toungoo, Shwegyin, Pegu and West Salween divisions, and in the Southern Circle in the Pyinmana and Ruby Mines divisions. In all 708 square miles of detail survey on the 4-inch scale was completed at a cost-rate of ₹98 per square mile. The health of the party was, considering the nature of the country operated in, fair, though 10 men died from fever and dysentery.

24. In the Central Provinces operations were carried on in the Saugor, Hoshangabad, Betúl, Nimár, Mandla, Seoni, Biláspur and Sambalpur districts, 1,423 square miles of survey being completed, at a cost-rate practically identical with that of last year.

25. In Bengal the survey operations were confined to the forests in the Singhbhum district, 185 square miles of which were mapped, the work being a good deal retarded by sickness among the surveyors and by the scarcity of drinking water.

26. In the Punjab the survey of Chamba State, which was made over to the Forest Survey Branch, was completed, 31 square miles being surveyed on the 4-inch scale and 249 square miles on the 1-inch scale. Some boundary work was done in the Montgomery district and triangulation was commenced in Hazára.

27. The total outturn of Forest Surveys executed on various scales during the year amounts to 4,723 square miles, of which 2,421 square miles were surveyed by the Forest Survey Branch. Classed by scales the figures are as follows:—

4,432	square	miles	surveyed	on the	4-inch scale.
236	"	"	"	"	8-inch "
55	"	"	"	"	16-inch "

CADASTRAL SURVEYS.

28. During the year under report, as in the preceding year, there was one cadastral party in Burma administered directly by the Deputy Surveyor-General, and one was employed in Bengal and one in the North-West Provinces under his general professional superintendence, while the programme and cost of the operations are entirely under the control of the local Governments.

29. The Burma party was mainly employed in the Lower Chindwin district in Upper Burma where an area of 816 square miles was traversed in advance and 829 square miles surveyed cadastrally on the 16-inch scale. A survey of Mandalay cantonments on the scale of 16 inches to the mile and of the cantonment bazars on the scale of 132 inches to the mile was also carried out. In Lower Burma the town and civil station of Toungoo were surveyed on the 64-inch scale and an area of 183 square miles in the Bawni circle, Pegu district, was resurveyed cadastrally owing to extensive alterations that had taken place since the original survey was executed. No writing of records is done by this department in Burma, but a separate establishment is maintained for the standard mapping and to assist the Settlement Department.

30. In Bengal an area of 917 square miles was surveyed cadastrally on the 16-inch scale and the records written in 731 square miles, all in the district of Darbhanga. In Monghyr district 542 square miles were traversed preparatory to cadastral survey by this department. Several minor surveys were also carried out of several private estates and municipalities and in connection with the boundaries of Government estates. The record of occupancy was completed of the Darbhanga town to accompany the maps of the previous season's survey.

In Bengal the detail survey is done entirely by *amins*, who also write the record of rights under the double supervision of the Survey and Settlement Departments.

31. In the North-West Provinces, the revision of village maps and records was continued as heretofore except that Nos. 2 and 8 Parties which had been employed on traverse surveys in these provinces under the direct administration of the Deputy Surveyor-General were this season amalgamated with the establishment employed on the revision surveys and placed under the orders of the local Government. At the same time the title of these surveys has been changed to "Provincial surveys" and the establishment has been divided into three sections, traverse, drawing and cadastral.

32. Traverse operations were continued in districts Etáwah, Etah, Mainpuri and Gonda and commenced in Jálaun. The total area traversed during the season is 2,644 square miles. The revision of maps and records was completed in the Pilibhít district, continued in Farrukhabad, Gonda and Azamgarh, and commenced in Etah, Etáwah and Mainpuri. In the Aligarh and Kheri districts special surveys of certain villages were carried out. The total area thus dealt with during the season is 3,882 square miles.

The detail survey was conducted entirely by *patwáris* where they were available, but *amins* or settlement *kánungos* were employed where *patwáris* were not forthcoming or had neither qualified in surveying nor nominated heirs to be trained in their places.

33. The total areas cadastrally surveyed in the several provinces are as follows:—

	Square miles.
Bengal	917
Burma	1,027
North-West Provinces	3,882

TRAVERSE SURVEYS.

34. During the year under report there were five detachments employed solely or mainly on traverse surveys—one in each of the provinces of Assam, the Central Provinces and the Punjab and two in Bengal. With the exception of those in Bengal, these detachments were under the direct superintendence of the Deputy Surveyor-General.

35. In Assam an area of 264 square miles composed of tracts scattered over the province was traversed, in accordance with the requirements of the local Government. A topographical survey on the 2-inch scale of 171 square miles

of the bed of the Brahmaputra river was also carried out and 71 linear miles of traversing along the Goálpára-Garo Hill boundary.

36. The Bengal detachments were under the orders of the Superintendent of Settlement Surveys in that province. One was employed in the Sonthál Parganas district and the other in Noákháli. In the former district 624 square miles were traversed in the Dáman-i-Koh Government Estate and 135 square miles in private estates, the cadastral survey of which will be carried out by the Settlement Department as in the previous season.

In Noákháli a traverse and plane-table boundary survey was done of certain islands aggregating 68 square miles in area with a view to ascertaining their areas and suitability or otherwise for cultivation.

37. In the Central Provinces the work of former seasons has been continued and traverse surveys have been carried out of 635 square miles in the *jágirs* of the Chhindwára district; 47 square miles in the *jágirs* of the Hoshangabad district; 203 square miles of *rayatwári* villages in the Nimár district and 91 square miles of *zamindári* villages in the Raipur district. An addition was made this season to the establishment of this detachment for the purpose of bringing the topographical maps of the province up to date from materials to be obtained from the cadastral surveys that are being carried out by local agency.

38. The Punjab Detachment which only came into existence this season was formed for the purpose of fixing the position of village boundary trijunction points by means of a theodolite traverse survey to enable the maps of the local *patwári* survey to be utilized for bringing the standard maps of the province up to date. An area of 2,530 square miles has thus been traversed in the Kohát district.

39. The areas traversed during the year excluding those traversed by cadastral parties for their own surveys are as follows:—

	Square miles.
Assam	264
Bengal	821
Central Provinces	978
Punjab	2,530
TOTAL	4,593

SPECIAL OPERATIONS.

40. No. 22 Party was employed in continuing the latitude observations. It was proposed to take latitudes on the Karáchi Longitudinal Series, but this arrangement had to be cancelled owing to the unusual scarcity of water in that district, and the party had to carry out latitude operations on the Biláspur Meridional Series. Observations have been taken at seven stations.

41. No. 23 Party was engaged on the determinations of latitude at two stations on the Great Arc Series, five of the Budhon Series and three of the Rangir Series with a view to the examination of the variation of Himalayan attraction. A new apparatus for the measurement of base lines by means of suspended wires the invention of M. Jäderin of Stockholm having been received, this party also took part in an experimental measurement of the Dehra Dún Base.

42. The tidal observations have been continued as usual. Automatic registrations with self-registering tide guages were continued at 13 stations in India, Burma, the Andaman Islands, the Persian Gulf and the Red Sea. Besides the automatic registrations mentioned above, personal tidal observations to graduated staves were taken at 5 stations with the object of comparing actual times and heights of high and low water with predicted times and heights. During the year under review the station at Diamond Harbour was closed and a new observatory at Port Albert Victor was opened. It is proposed to close the Bushire Observatory and start work at Bassein during the ensuing season.

43. The levelling party was divided into two sections. The double levelling section worked from Calcutta to Damukdia a distance of 124 miles fixing the heights of 11 embedded and 65 inscribed bench-marks. The single levelling section, which was specially formed at the request of the Railway authorities, worked over certain branch lines of railway, the outturn being 278 miles, fixing the heights of 28 embedded and 161 inscribed bench-marks, and of two stations of the Great Trigonometrical Survey.

44. In connection with the Magnetic Survey about to be inaugurated, Captain H. A. D. Fraser, R.E., proceeded to England on deputation on 18th May 1899 to arrange for the purchase of Magnetic instruments and to study the methods of observation in vogue at Kew. When his period of deputation expired on the 30th June 1899 he remained in England on furlough till 30th September 1900. He was replaced on duty in England under the orders of the Secretary of State for India on 1st October 1900, and he is expected to arrive in India in December 1900, when he will be given charge of the Magnetic Party that is now being formed. Dehra Dún has been selected as one of the base-stations of the Magnetic Survey, and a Magnetic observatory is being built there. Sub-Assistant Superintendent Aulad Husein has been appointed the Magnetic observer at Dehra Dún: he joined at Dehra Dún on the 11th May 1900, and during the summer studied the theory of Magnetism, the methods of observation, and the use of the instruments.

GEOGRAPHICAL SURVEYS AND RECONNAISSANCES.

45. Under this head are included surveys and reconnaissances which are executed on the scale of $\frac{1}{2}$ inch = 1 mile or smaller scales. During the year an area of 3,256 square miles was surveyed on the $\frac{1}{2}$-inch scale in Kashmir and reconnaissance surveys over an area of 27,515 square miles on the $\frac{1}{4}$-inch and $\frac{1}{8}$-inch scales were carried on in the North-Western frontier.

On the Eastern frontier Captain Ryder spent the field season in reconnaissance work in Yunnan, adding largely to our geographical knowledge of that region. The party under Major Renny-Tailyour which was attached to the Burma-China Boundary Commission also reconnoitred a considerable area of country and a party under Captain Robertson accompanied a military expedition against the Mishmi tribe on the extreme north-eastern frontier of Assam and made a reconnaisance survey of 808 square miles on the $\frac{1}{2}$-inch scale.

Captain Hare with Mr. Hertz as a Political Officer was engaged for part of the season in exploring the Nmai Kha, the Eastern branch of the Irrawaddy.

The total area reconnoitred on this frontier on the $\frac{1}{4}$-inch scale during the season amounts to upwards of 92,000 square miles.

HEAD-QUARTERS OFFICES.

46. The details of the work done in the various offices at head-quarters are given in Part III of the report. The offices in Calcutta, as usual, were supervised by three Assistant Surveyor-Generals; Mr. A. E. Spring continued in charge of the Drawing, Engraving and Map Record and Issue Offices and also of the Bengal Provincial Drawing Office up to the 28th June 1900, when he proceeded on leave and Major J. M. Fleming, I.S.C., succeeded him, continuing in charge up to the close of the year. Mr. T. A. Pope continued in charge of the Photo-Litho. Office throughout the year. The Correspondence and the Mathematical Instrument Offices were at different periods under Captain P. J. Gordon, I.S.C., Majors J. M. Fleming, I.S.C., and F. B. Longe, R.E.

47. The geographical section of the Drawing Office has again been busily employed with the maps of the N.E. and S.E. Frontier Series; new editions of three sheets have been published and of 17 are under publication while 17 other sheets have been brought up to date.

Of the 1-inch standard sheets 14 new sheets of Upper Burma and one of Assam have been published in addition to 18 sheets of the special survey of the Burma-China boundary. New editions of 72 sheets of various parts of India have also been published, while 15 new sheets of Upper Burma, one of Assam and one of Bombay and new editions of 11 various old publications are in hand, three being sheets of Upper Burma.

48. The maps of India on various scales have all been in hand for revision in the matter of railways, boundaries, &c. Sheet No. 4 (Burma) of the 32-mile engraved map has had much additional topographical work added to it which has also been drawn for engraving on the duplicate plate of the map of India on the scale of 1 inch = 64 miles. A new map on this last scale is being compiled and has been projected on copper.

49. The stones of the 32-mile lithographed map of India have become quite worn out, and a new set is being prepared by transfers from the engraved

skeleton plates, which will be brought up to date; the hills being drawn on the stone for publication in two colours.

50. The Railway map of India on the scale 1 inch = 32 miles has been brought up to date. The District maps on the scale of 1 inch = 8 miles, the Provincial maps on the scale of 1 inch = 16 miles and the Administration maps on various smaller scales are all brought up to date.

51. As usual there has been a large amount of work in the way of map making and supplying professional data for other departments, and these demands which are almost continuous and increasing have much interfered with and retarded the legitimate work for which the office was designed. In many cases it is quite plain the applicants do not appreciate the amount of work their demands entail. The most important non-departmental map in hand has been that for the new Bengal Route book drawn for reduction to half (1 = 32 miles) scale. Proofs of this were sent for examination, but were returned with numerous additions and corrections, and it must be some considerable time before the map can be issued. The Military map of India on the same scale was also completed during the year and published. Maps of China on the scale of 1 inch = 72·8 miles, and the Yangtze Valley were drawn in two colours, at very high pressure, necessitating the suspension of all other work, in response to an urgent demand from the Quarter-Master General. The preparation of a set of provincial maps for Census purposes has also been commenced.

A beginning has been made of a much needed revision of the Provincial map catalogues and those of Bengal and Punjab have been completed. That of the North-Western Provinces is in hand.

52. In the Revenue Section the map of Calcutta in two sheets on the scale of 6 inches = 1 mile which was prepared last year has had additional material and corrections added and is at press. Seven sheets of Burma on the 1-inch scale have been revised from material supplied by the Director, Land Records, Burma, from local surveys on the scale of 16 inches = 1 mile. Two sheets of Pesháwar district have been compiled on the scale of 1 inch = 1 mile from the 4-inch settlement trace maps which are themselves reductions from the original *patwáris* surveys. The publication of these sheets has been delayed owing to discrepancies between them and the professional surveys which they meet on the north.

53. A number of standard sheets of the North-Western Provinces, Bengal and Burma have been brought up to date, also 18 sheets of Assam and of Bombay and Sind. The republication of the old Bengal sheets is a most unsatisfactory undertaking. The originals being drawn in colours are not fit for reproduction and lithographed copies have to be utilized as originals. An immense amount of touching up is entailed and after all a most unsatisfactory result is obtained.

54. The comparision of the coloured office copies of maps from which issues for the public are made with those on which corrections are from time to time entered as received, as well as the replacing of dilapidated sheets has been commenced. A large number of volumes of computations were received from the field parties and cursorily examined, and copies of traverse data, village maps, etc., have been supplied to officers of the department and other Government officials.

55. In the Cadastral Section 4,402 sheets were published of which 3,522 belonged to Burma, 213 to Bengal (Tikári Ward's Estate, district Gaya), and 667 to Assam.

56. The Bengal Provincial Drawing Office continued the compilation of standard sheets from the cadastral maps of Bihar, Orissa and Chittagong. The outlining and typing of six standard sheets of Bihar were completed; also the outlining and typing of two standard sheets of Chittagong and one standard sheet of Orissa was drawn, completed and reduced by photography. Of the special edition of maps on the scale of 2 inches = 1 mile for the Government of Bengal, showing the irrigated area of Orissa, nine sheets were published. Owing to numerous corrections to the village names on the standard sheets by the Settlement Department, a very large percentage of the names had to be retyped and the sheets had again to be photographed, consequently the publication of the maps has been delayed.

57. The work in the Engraving Office has steadily continued to progress. The preparation of the quarter sheets of the Atlas of India has been the chief

task in hand and the outturn is on the whole in excess of what was accomplished last year. While only three Atlas sheets have been completed, new material has been added to 75 quarter plates which are in various stages of progress. Thirty-four new plates have been projected or had borders cut on them, and taking into account all kinds of work taken up, 281 plates have been dealt with.

58. The maps of India on the scale of 1 inch = 64 miles both with hills and in skeleton having become antiquated, have been in hand for completion with railways to date, and a new map on the same scale has been projected. Meanwhile a duplicate of the old map has been prepared which will be revised where most faulty and brought up to date in railways and, where possible, in spelling. The maps on scales of 1 inch = 80, 128, and 256 miles are also being brought up to date. The Route Map of the Western Himálayas 1 inch = 32 miles has also been in hand, but much still remains to be completed; and the Map of the Punjab and Adjacent countries on the same scale has also had heavy additions made to it. New work has been engraved on the 16-mile map of Bombay and on that of Madras on the same scale. The maps of Gujarát, Central Provinces, Bengal, Mysore and N.-W. Provinces on the 16-mile scale have also had corrections and additions made to them.

59. The work of the copper-plate printing section is much hampered by insufficient space, and to enable the demand for Atlas sheets to be met, the necessary stock must be obtained by transfers from the plate on to zinc, from which the sheets will be printed elsewhere until such time as space for extra presses can be provided.

60. The Photographic and Lithographic Office has again executed a very large and varied outturn of work during the past year, and in several sections the large outturn of last year has been considerably exceeded. The amount of work received from other departments was as large in quantity as last year, while there was a considerable increase in the amount of work done for the Survey Department. The number of copies printed by the machines and presses, however, is smaller than last year, although the number of subjects reproduced, and consequently the actual amount of work done, was much larger. There are still a large number of standard sheets of the Revenue and Topographical surveys awaiting completion, and but little could be done towards clearing off these heavy arrears, the entire strength of the sections dealing with these maps having been engaged throughout the year on urgent current work.

During the year, 7,459 subjects of all kinds were received and put in hand for reproduction, being an increase of 586 over the number received last year. Of these, 6,338 were completed in all respects during the year, and most of the remainder were approaching completion at its close. Of the total number received, 983 were maps furnished by the Survey Department, which exceeded the number sent in last year by 329; 4,942 were cadastral maps, or 247 more than last year; and 1,534 were subjects received from other departments, or 10 more than last year. The outturn of the litho. and zinco. presses and machines, as measured by the number of pulls from stone and zinc, is slightly larger than last year, the total number of pulls being 1,010,053, as against 982,220 last year. The actual number of copies of maps, etc., represented by this outturn was 850,502, as against 965,453, which is due to a larger proportion of the work having been printed in colours than was the case last year. This number comprises 99,176 copies of departmental maps, 162,733 copies of cadastral maps, and 588,593 copies of extra-departmental subjects, the figures for last year being—departmental copies 135,094, cadastral 136,630, and extra-departmental 693,729. The Type-printing Section shows a large increase of work: the number of subjects set up in type was 15,146, or 1,214 more than last year; the number of pulls, 1,478,081, or an increase of 200,132; and of copies, 812,127, or an increase of 128,088. In the Silver-printing Section there was also an increase both of ordinary silver prints and of cyanotype work, the number of the former turned out being 971, as against 120 last year, and of blue prints 2,392, as against 1,631. In the Heliogravure Section less work was done, owing to the cessation of the demands for photogravure work from the Archæological Survey which have been regularly received for several years past, and to the completion of the work illustrating Dr. Hoernle's report on Central Asian Antiquities. Only 60 photogravure plates were etched, or 68 less than last year, and 56,570 copies were printed, or 29,944 less.

61. The most important event of the year in the office was the invention by one of the European assistants of a remarkably simple, cheap, speedy and effective method of obtaining a printable image in greasy ink on a zinc plate by direct printing through an ordinary black and white original drawing placed in contact with the plate. The details of this process are given in full in the appendix. It is entirely novel and has been granted a patent in India. A small section has been formed, known as the Direct Zinc-printing Section, for the working of the process, and since the beginning of September 1900 a steady and regular outturn of work has been executed by it, which, while comparing favourably in quality and in the time occupied in its execution with that yielded by the ordinary method of photo-zincography, is also produced at a much lower rate of cost. The work now being turned out consists of the sheets of the Orissa cadastral surveys, of which 8,300 have been sanctioned by the Bengal Government for reproduction by this process, and it is understood that a large additional number may be expected when these are printed off. The rate charged is R1-3 per 10 copies of each sheet, including all charges, or about one-ninth of the regular rate for cadastral work executed by photo-zincography. At present the Bengal cadastral work occupies the whole time of the small section, working at the rate of 24 to 30 plates *per* day ; but on the completion of this work it will be available for the reproduction of a large quantity of other work which is now done by photo-zincography. It is hoped that Mr. Vandyke, the inventor and patentee of the process, will receive some suitable recognition at the hands of Government.

The erection of a much-needed building for the accommodation of the Type Section, at the rear of the main building, was commenced shortly before the close of the year, and will be completed in December 1900. The removal of this section from the main building will enable various improvements to be effected in the arrangement of the printing machinery which for want of space could not be carried out before, and will greatly conduce to the efficient working of the Type Section.

The more important publications of the year are referred to in Part III, where also will be found an abstract statement showing the actual outturn of each section.

62. In the Map Record and Issue Office the number of new departmental maps and editions received during the year amounted to 4,666, of which 4,466 were cadastral maps. The total number of maps issued was 2,58,709 valued at R2,79,123 which shows an increase of 63,961 in number and R63,928 in value over those of the preceding year. The amount realized for maps sold amounted to R23,258, which also shows an increase of R2,342 over the cash receipts of 1898-1899. The space available for the storage of both the original and printed maps is now quite insufficient for the stock, which is of course yearly increasing, and the question of providing more accommodation is a very serious problem.

63. In the Mathematical Instrument Office, the total number of instruments issued was 59,743 and their value R2,88,770 against 72,514 and R2,59,435 for the previous year. The number of instruments received into store was 57,160, and their value R2,54,922 against 61,407 and R2,84,208 last year. The number of instruments received on indent from England has again decreased, as the stock did not require replenishing : the purchases in the local market were practically the same as last year in number, though the value was greater by R1,383. The number of instruments taken from the repairable stock and rendered serviceable was 2,725 and their value R91,882 against 4,118 and R1,07,967 last year. The decrease in number and value is due to the fact that this year the older patterns of instruments were converted to modern types instead of being merely repaired and kept in the same form.

64. During the year 140 levels and 98 theodolites of old patterns have been converted into serviceable instruments, making the totals 627 and 290 respectively since the increased establishment for the repair of instruments was sanctioned, and, except when special patterns were required, indents on England for such instruments have been discontinued. The value of instruments indented for for 1900-1901 amounts to £5,179, which is almost the same as last year's figure.

Owing to various causes it has been found necessary to revise the prices of nstruments and a new catalogue will be issued shortly.

A scheme is in contemplation for the re-organization of the workshops, by which a larger outturn of work will be ensured and expenditure reduced at the same time.

65. In the Trigonometrical Branch Office experiments were made with Bridges-Lee Photo-theodolite to test its qualities as a photo-telemeter and very satisfactory results were obtained. It is quite possible that this instrument might prove a valuable adjunct when rapid topography is a necessity.

A set of M. Jäderin's base line apparatus was obtained in February from Messrs. Ahlberg and Ohlson of Sweden and the Dehra Dún Base was measured with it as an experiment, but until the co-efficients of expansion of the wires have been redetermined, the observations cannot be reduced.

66. The usual meteorological and magnetic observations were continued throughout the year. It is expected that a set of automatic instruments will be installed early in 1901 in the new observatory under construction. In the solar-photography which was continued as usual, dry plates have been mostly used with very satisfactory results.

Three officers of the Imperial Service went through a practical course of trigonometrical, topographical and astronomical work and were posted to field parties. Eight of the Provincial officers, of whom seven were on probation, and 17 apprentice sub-surveyors were put through a course of topographical surveying and mapping.

67. The head-quarters offices of the Forest Survey Branch at Dehra Dún were under the superintendence of Mr. W. H. Reynolds throughout the year, and were employed as usual upon correspondence and accounts and final computations in connection with the work of the several field sections of the Forest Survey Branch; up-keep of map records, compilation and drawing of special maps and other miscellaneous work of the Forest Department. During the year, 155 special maps and standard sheets on various scales were published, 135 were passing through the press and 299 were in different stages of progress. In addition to the above 2,652 printed maps were coloured, 365 tracings were prepared and 1,852 maps were mounted for the Forest Department and district officers.

ESTABLISHMENT.

68. During the year under report the Department has lost the services of three officers of the Imperial service. Mr. E. J. Jackson, Superintendent, 1st grade, retired from the service on superannuation on 1st November 1899. He joined the Junior Division (now Provincial Service) on the 26th September 1864. He was promoted to the Imperial Service on the 5th November 1868. During his entire service of over 35 years he was principally employed on Revenue survey operations in Bengal, Assam, Central Provinces, North-Western Provinces and Burma. He also held charge of Forest operations in Lower Burma and in Madras for short periods, and was also temporarily attached to the head-quarters office, Calcutta.

69. Mr. W. H. Reynolds, Superintendent, 1st grade, and Superintendent of Forest Surveys, Bengal Presidency, retired from the service from the 1st October 1900. He joined the Junior Division (now Provincial Service) on the 14th March 1861 and served in the North-Western frontier districts and in Kashmir up to 31st December 1870, when he was transferred to the Forest Survey Branch, as Assistant Conservator, 3rd grade. He was promoted to the post of Deputy Superintendent of Forest Surveys on 1st September 1878 and to that of Superintendent of Forest Surveys on 2nd February 1887. This appointment he held up to the date of his retirement. His name was retransferred to the Survey of India Department in 1890. He was granted an extension of service for about 2 years and a half. Mr. Reynolds also served with the Ambela Expedition in 1863, for which he received a medal and clasp.

Lieutenant B. R. Daunt, I.S.C., who was appointed a probationary Assistant Superintendent, 2nd grade, on the 31st October 1898, reverted to the Military Department on the 13th November 1899 on account of ill health.

70. In the Provincial Service the Department has lost the services of six officers during the year by retirement, *viz.*:—Messrs. G. Belcham, A. G. Wyatt, A. D. L. Christie, J. H. O'Donel, C. E. Tapsell and R. Todd.

PART II.

THE OPERATIONS OF THE SEVERAL FIELD PARTIES.

TRIGONOMETRICAL SURVEYS.

INDIA TRIANGULATION.

No. 24 PARTY.

71. The party under Lieutenant Turner started from Calcutta on the 27th October, arriving in Rangoon on the 31st, and Sagaing the 2nd November.

Personnel.

Lieutenant H. H. Turner, R.E., Officiating Deputy Superintendent, 2nd grade, in charge.
Lieutenant H. Wood, R.E., Assistant Superintendent, 1st grade, up to 12th May 1900.
Mr. J. Hickie, Extra Assistant Superintendent, 4th grade, up to 16th April 1900.
Mr. D. J. Hunter, Sub-Assistant Superintendent, 3rd grade.
Mr. H. R. Hunter, Sub-Assistant Superintendent, 3rd grade.
Mr. P. Morton, Sub-Assistant Superintendent, 3rd grade.

A halt of four days was made at Sagaing, and opportunity was taken to separate the party into two sections, the one under Lieutenant Turner proceeding by Government steamer up the Chindwin river on the 7th November, the other under Lieutenant Wood commenced work from the base Sheinmaga-Mingun, just north of Sagaing.

72. Lieutenant Turner's work was to start a new minor meridional series from the base Khambiching-Tamunja side of the Manipur Longitudinal Series, and from thence work south approximately along the meridian 94° 15′. He commenced observing from Khambiching H.S. on December 6th, the journey by river and road from Sagaing having occupied three weeks. Work being once commenced, proceeded rapidly, one to one and a half day's observing at each station being sufficient to complete both horizontal and vertical angles. The weather up to the middle of February was on the whole favourable; from that time on the haze began and by the first week in March was so thick that it rendered all hopes of further work for the season out of the question.

Lieutenant Wood, starting from the base Sheinmaga-Mingun of the Mandalay Meridional Series, ran a secondary series westward across the Irrawaddy and Chindwin valleys just north of Latitude 22° N. to meet the meridional series of Lieutenant Turner. He completed this series up to the point where it would meet the other series. The country in the Irrawaddy and Chindwin valleys proved very difficult for triangulation, but after crossing the Chindwin no difficulty was experienced.

73. Lieutenant Turner for his work used No. 3 Troughton and Simms 12-inch micrometer theodolite, and he observed on four zeros with from two to four measures on each zero. Lieutenant Wood used Messrs. Troughton and Simms 8-inch micrometer theodolite, No. 956, and observed on six zeros with from four to twelve measures on each zero.

74. The season's outturn of work was as follows:—

LIEUTENANT TURNER.

Number of stations newly fixed	11
Number of figures completed	11
Length of series completed, in miles	102
Area of triangulation, in square miles	2,032

LIEUTENANT WOOD.

Number of stations newly fixed	15
Number of figures completed	9
Length of series completed, in miles	113
Area of triangulation, in square miles	1,472

Lieutenant Turner's mean triangular error was 0·88.″
Lieutenant Wood's mean triangular error was 2·375.″

75. The health of the party was on the whole good, though there was a good deal of fever at the commencement of the season. One man died at

Kindat of fever, and one man was drowned, falling off the ferry boat on his way from Pakôkku to Sagaing at the end of the field season.

Major Burrard, Superintendent, Trigonometrical Surveys, inspected the party on the 20th and 21st June 1900.*

TOPOGRAPHICAL SURVEYS.

LOWER BURMA.

No. 3 Party.

76. Mr. Litchfield assumed charge of the party from Mr. Claudius on the 16th September 1899, and remained in charge throughout the year under report. Mr. Keating, who was transferred from No. 14 Party, joined at Prome on the 1st November 1899. Mr. Gastaud was transferred to the Central Provinces Drawing Office on the 1st of September 1900, and Mr. Corridon to No. 25 Party on the 1st of August. Three sub-surveyors joined the party in December, and two were transferred to No. 20 Party.

Personnel.

Mr. E. Litchfield, Deputy Superintendent, 2nd grade, in charge.
Mr. J. Keating, Extra Assistant Superintendent, 5th grade, from 1st November 1899.
Mr. C. George, Extra Assistant Superintendent, 6th grade.
„ M. Gastaud, Extra Assistant Superintendent, 6th grade, to 31st August 1900.
Mr. J. Donaghey, Sub-Assistant Superintendent, 2nd grade.
Mr. E. H. Corridon, Sub-Assistant Superintendent, 3rd grade, to 31st July 1900.
Asmatulla Khan, Surveyor.
23 Sub-Surveyors and Interpreters and 1 Writer.

77. The party left recess quarters at Bangalore on the 8th November, and returned on different dates between the 17th of June and the 23rd of July, the dates of closing work varying with the localities in which the camps were working. The party was divided into four camps: the head-quarters camp at Prome; the Yenangyat Oil-field survey camp in the Pakôkku district of Upper Burma under Mr. Keating; the Sandoway camp under Mr. George; and the Pegu camp under Mr. Gastaud. The triangulators and three plane-tablers working on the Irrawaddy were under the direct supervision of Mr. Litchfield, as were also, for the greater part of the field season, Messrs. Donaghey and Corridon, who were plane-tabling on the 1-inch scale in the Sandoway district. These two assistants were for a short time placed under Mr. George for convenience of supervision.

78. The programme proposed was —

(*a*) The detail survey on the 1-inch scale of parts of standard sheets 117, 118, 119, 120, 160, 163, and 164.

Portions of sheets 160, 163 and 164 had been published as first editions, the maps having been compiled from cadastral surveys by the Survey Department during 1882—85 and from surveys executed by the Land Records Department, but without the hills. The details in these areas were carefully tested and supplemented where necessary, and the hills surveyed.

(*b*) The detail survey on the 2-inch scale of two blocks, aggregating 525 square miles, in standard sheets 259, 260 and 261 of the Pegu district to complete the sheets surveyed by No. 20 Party.

(*c*) The triangulation for a 1-inch survey of as much as possible of the unsurveyed area embraced by sheets 113, 114, 115, 157, 158, 159, 205, 206, and 207 in the Thayetmyo district.

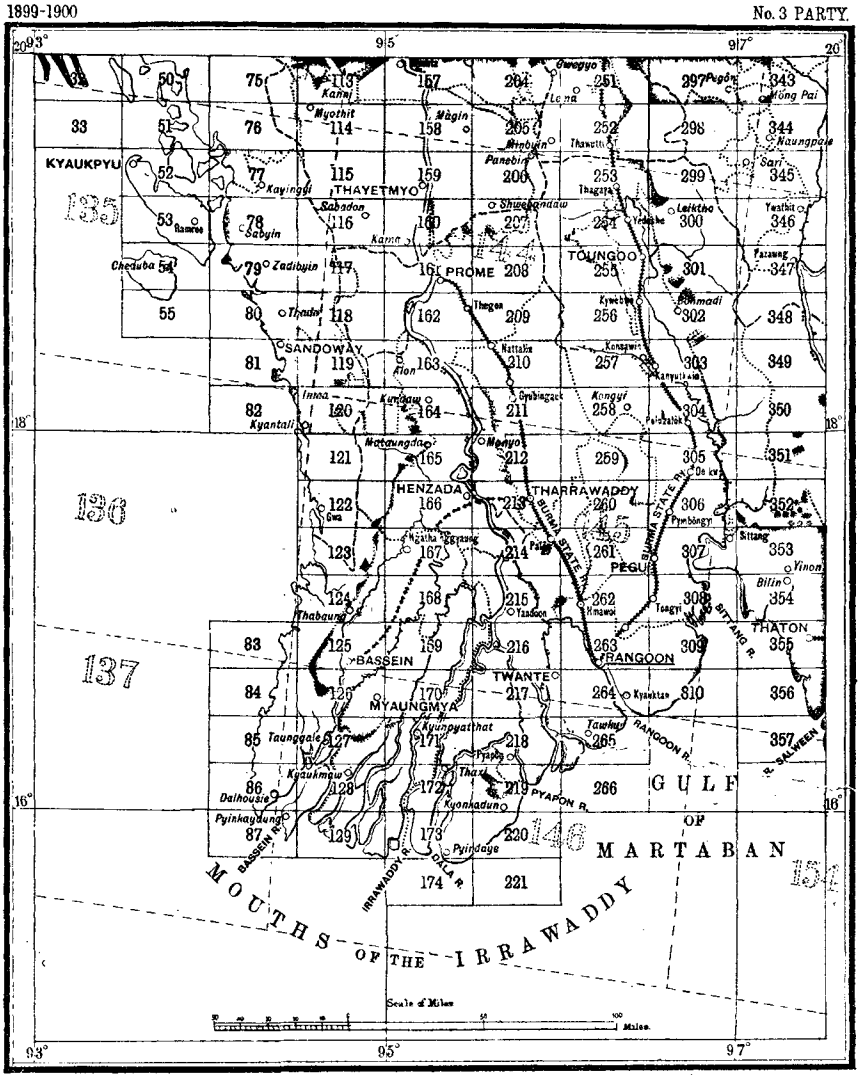
(*d*) The detail survey on the 8-inch scale of 45 square-mile blocks of the Yenangyat Oil-field in the Pakôkku district, Upper Burma.

This last was twice modified at the instance of the local Government. Firstly, the survey of 12 blocks, occupying mostly cultivated land in the north-east corner of the area to be surveyed, was to be abandoned and that of an equal number to the north substituted,

* Lieutenant Turner reports that Mr. Hickie did excellent work both in the field and recess while attached to the party, and that Messrs. D. J. Hunter, H. R. Hunter and Morton have given satisfaction. Sub-Surveyors Ibrahim Khan, Mangat Rai and Jai Sing are reported to have done well.

INDEX TO THE TOPOGRAPHICAL SURVEY IN LOWER BURMA

1899-1900 No. 3 PARTY.



NOTE

The numerals 263 &c. indicate the Standard sheets to the Scale of 1 Inch=1 Mile

The names of Cities Surveyed on large Scale are underlined thus RANGOON

The figures and lines in circles represent the numbers & limits of the Engraved sheets of the Indian Atlas.

REFERENCE

Area Surveyed previously

" during 1899-1900

" Triangulated in advance

" 1899-1900

Photo, S. I. O., Calcutta.

Reg. No. 371, S. I. D.—Feb. 01.—550.

No. 313-S. 01.

and secondly, the detail survey was countermanded, and the work was confined to the demarcation of the blocks—involving the erection of a pillar at each corner—and to a skeleton survey on the 4-inch scale of the pillars and corners of the blocks; at the same time the number of blocks was increased by 76, making a total number of 142 blocks, 21 of which had been surveyed previously by local agency.

79. The outturn of the field season's work is as follows:—

	Square miles.
Triangulation for 8-inch survey (Yenangyat)	537
" " 1 " "	3,220
Detail survey on the 1-inch scale, excluding 176 rejected	1,508
" " " " 2-inch "	310
" " " " 8-inch " Yenangyat	19
Demarcation and skeleton survey on the 4-inch scale Yenangyat	102

80. The total expenditure of the party is ₹106,568 and the cost-rates *per* square mile are as follows:—

	₹	a.	p.
Triangulation for 1-inch survey	4	13	2
" " 8-inch " (Yenangyat)	7	12	4
Detail survey on the 1-inch scale	25	7	2
" " " 2-inch "	94	3	8
Skeleton " 4-inch " Yenangyat	98	3	9
Detail " 8-inch " Yenangyat	267	2	6

The Yenangyat oil-field survey, being of a special nature, accounts for the high cost-rate attained. This survey was called for at the instance of the Burma Government who bears its cost.

81. The health of the party as a whole was not good, owing to the unhealthiness of the localities in which work was carried on, the prevailing complaints being malarial fever and dysentery. Messrs. Donaghey and Corridon were sent on leave on medical certificate before the close of the field season. Several of the sub-surveyors suffered a good deal, and some were in hospital for various periods. The *khalâsis* suffered most; amongst these there were five deaths, one case of paralysis and one man was badly mauled by a bear.

82. The country under survey in the Sandoway district was similar to that described in last year's report.

In Pegu, with the exception of parts of the Tandawgyi circle, the country is composed of low hills of a fairly uniform height of 300 to 400 feet above sea level, with undulations of 50 to 100 feet above ground level, the intervening hollows being marshy—most of it is covered with a dense tree forest and undergrowth, in which elephants, tigers and bears are fairly numerous.

At Yenangyat the ground surveyed is hilly, rising to about 1,200 feet at the north end, and much cut up. The hills are bare, the only growth being a few hardy species, such as the *khair*, *cactus*, etc. The soil is probably impregnated with mineral oil and salts. The climate is dry and hot, the average rainfall being about 28 inches.

83. The party was inspected in the field by Major Longe, Officiating Deputy Surveyor-General, in April, and during the recess by Colonel Hobday, Deputy Surveyor-General, in August; and by Colonel Gore, Surveyor-General, in September.*

* Mr. Litchfield reports very favourably of Messrs. Keating, George, Gastaud and Corridon, and of Surveyor Asmatulla Khan; of the sub-surveyors, he particularly mentions Mahomed Husein, Mulk Raj, Ram Sarup and Rohan Lall and Writer Nisarali Khan.

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UPPER BURMA.

No. 10 Party.

84. Major Fleming took over charge of the party from Mr. Cusson, on the 10th October 1899, and held charge from that date to 2nd March 1900, when he handed over the party again to Mr. Cusson. The latter remained in temporary charge from 3rd to 30th March 1900, when he was relieved by Captain Hare who held charge from 31st March to 30th June 1900, on which date he handed over the party finally to Captain Pirrie, who remained in charge from 1st July until the close of the year.

Personnel.

Major J. M. Fleming, I.S.C., Superintendent, 2nd grade, in charge from 10th October 1899 to 2nd March 1900.
Captain F. W. Pirrie, I.S.C., Deputy Superintendent, 2nd grade, in charge from 1st July 1900.
Captain H. J. Hare, R.E., Officiating Deputy Superintendent, 2nd grade, in charge from 31st March to 30th June 1900.
Lieutenant E. T. Rich, R.E., Assistant Superintendent, 2nd grade, from 21st August 1900.
Mr. G. D. Cusson, Extra Assistant Superintendent, 4th grade, in temporary charge from 1st to 9th October 1899 and again from 3rd to 30th March 1900.
Mr. P. J. Serrao, Extra Assistant Superintendent, 6th grade.
„ F. P. Walsh, Sub-Assistant Superintendent, 1st grade, from 14th December 1899.
Mr. M. C. Petters, Sub-Assistant Superintendent, 2nd grade, from 10th October 1899.
Mr. C. C. Byrne, Sub-Assistant Superintendent, 2nd grade.
„ W. G. Jarbo, „ „ 3rd „
9 Sub-Surveyors, 6 Apprentice and Probationary Sub-Surveyors, 1 Writer, and 1 Hospital Assistant.

85. The party left recess quarters at Bangalore in two detachments, the first under Mr. Cusson, on the 2nd November 1899, and the second, including the head-quarters and remainder of the party, under Mr. Byrne on the 9th November 1899, and arrived in Mandalay on the 8th and 17th respectively.

86. The survey operations were of the same nature as in the year 1898-99 and consisted of 1-inch topographical surveys in the Shwebo, Mandalay and Ruby Mines districts, Upper Burma; revision of topographical detail on 1-inch reductions from cadastral surveys in districts Kyauksè, Meiktila, and Yamèthin; triangulation for next year's detail survey, and the completion of the 16-inch to 1 mile map of the cantonment and town of Maymyo, which had been commenced in the field season 1898-99.

87. Owing to the scarcity of water in the Ruby Mines and adjoining districts after February that portion of the 1-inch survey had to be taken up and completed before the detail survey was begun in the other districts, where water was plentiful throughout the year.

88. Major Fleming inspected the work of the surveyors in the Ruby Mines and adjoining districts early in the season, and they were subsequently visited by Messrs. Cusson and Walsh before the work was finally completed on 19th April 1900.

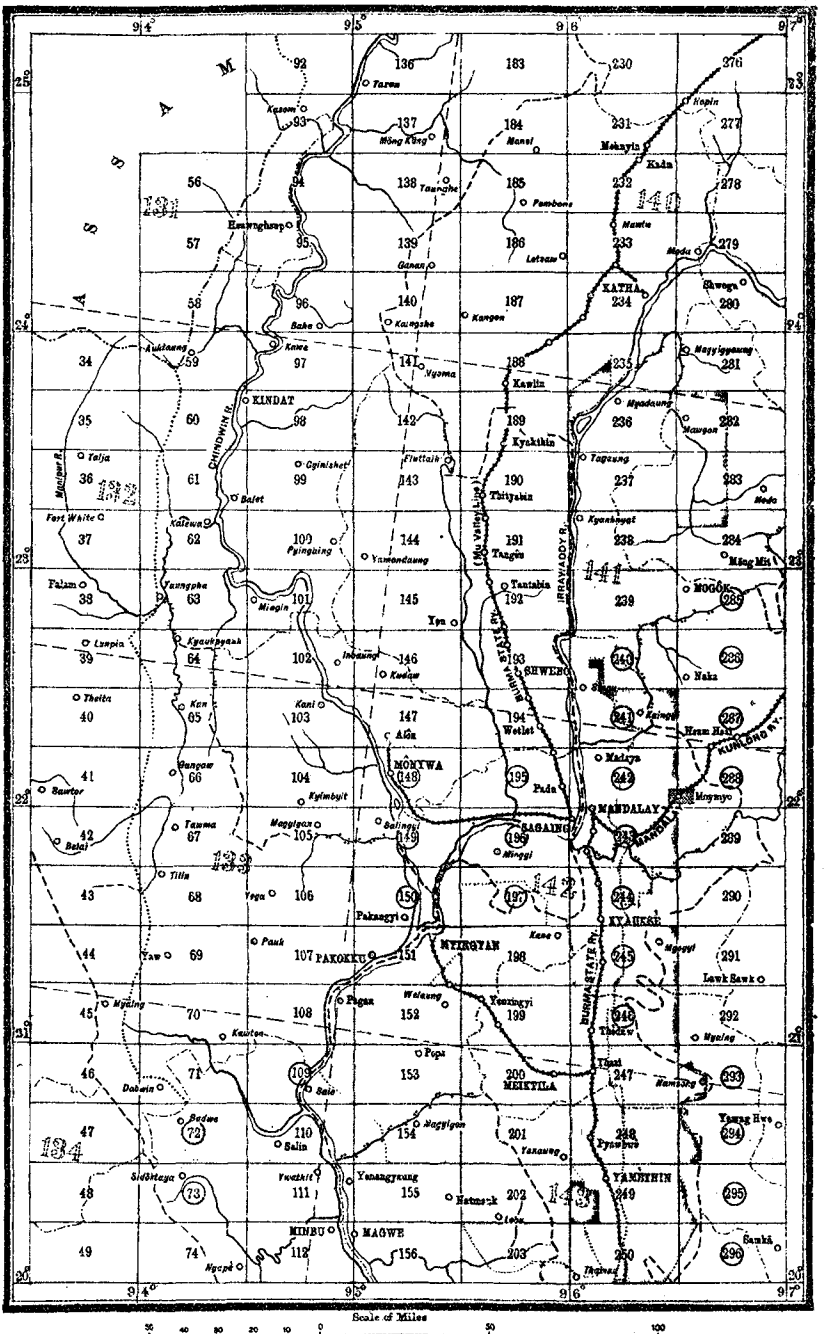
89. The revision of the topographical details in the cadastral surveys of districts Kyauksè, Meiktila and Yamèthin falling in standard sheets 245, 246, 247, 248, was entrusted to a detachment working under Mr. Walsh. Owing to the different methods of survey, symbols used, the absence of relative heights and the minor importance to revenue surveyors, of physical features compared with cultivated ground and boundaries, the topography in the revenue maps was generally found to be only approximately correct, except where the ground was absolutely flat and so far this revision work has been found a great deal more troublesome, and to require a great deal more supervision than the survey of new ground.

90. The completion of the Maymyo survey on the scale of 16 inches to 1 mile was taken up in the middle of March 1900 by a detachment working under Mr. Byrne, and was completed by 21st May 1900. The total area—16,646 acres—had been cadastrally surveyed by No. 7 Party, of which 5,157 acres had been topographically surveyed by this party during the field season 1898-99, so that 11,489 acres remained to be topographically surveyed during the field season under report. The method of topographical survey introduced in 1899 was again followed with slight modifications, the chief of which was the running of a series of levels between initial heights to check the contouring.

UPPER BURMA SURVEY.

INDEX TO THE TOPOGRAPHICAL SURVEY IN UPPER BURMA.

1899-1900. No. 10 PARTY.



The numerals 243 &c., indicate the Standard sheets on the Scale of 1 Inch = 1 Mile.
The figures and lines in stroke represent the numbers & limits of the Engraved sheets of the Indian Atlas.

REFERENCES.

Sheets published are shown thus 243
Area previously Surveyed .....
.... Surveyed in Season 1899-1900 .....
... Triangulated in advance .....
..... in Season 1899-1900 .....
Revenue Survey reductions revised .....
Maymyo Survey on 16 Inches = 1 Mile. .....

Reg. No. 411, S. I. D.—Jan. 01.—553.

No. 308-S. 01.

91. The outturn for the field season was as follows :—

	Square miles.
Triangulation	6,550
Detail survey on the 1-inch scale	2,000
Ditto 16-inch „	18
Revision survey	1,350

92. Triangulation was carried on in parts of Sagaing, Meiktila, Myingyan, Magwe, and Yamèthin and embraced the remaining portions of sheets 245, 246, 247, 248, 249, 250, the whole of sheets 198 199, 200, 201, 202, 152, and 153 and parts of sheets 197, 203, 150, 154, 108 and 109. Of the area triangulated, Mr. Serrao completed 4,500 square miles and Mr. Petters 2,050 square miles. The country round about Meiktila and in the neighbourhood of Popa hill was very suitable for triangulation, but great difficulty was experienced by Mr. Petters in triangulating in the thick forest country in sheets 202 and 203 west of Yamèthin.

93. The new 1-inch detail survey completed during the field season comprises an area of 2,000 square miles in sheets 238, 239, 240, chiefly in the Ruby Mines, but partly in Shwebo and Mandalay districts, together with a small portion re-surveyed in the east half of sheet 244 and the survey of a small portion of ground west of the Panlaung river in sheet 295, which had been omitted when the rest of the sheet was surveyed. The outturn for the field season again shows an increase both in quantity and quality.

94. The health of the party during the field season was surprisingly good considering the unhealthy nature of the country under survey in the Ruby Mines district. One sub-surveyor died at the close of the field season.

95. Field work closed about the middle of May, and by the last day of the month the whole party had returned to recess quarters at Bangalore. During recess the computations of the triangulation executed during the field season were completed. No triangulation charts were drawn. Standard sheets 246 and 247 were completed ; sheets 245 and 248 were completed as far as possible, but had to be put aside, owing to certain data not being available ; also sheets 238 and 239, as there was no draftsman available to take them up ; sheets 240 and 244 were sent to be completed in the Drawing Office, Calcutta. The whole of the Maymyo maps were fair drawn and sent to Calcutta for reproduction in two colours and will be an accurate representation of Maymyo as it existed when surveyed, but a great deal of detail such as new buildings, new roads and sites for Government offices, which have been made since the place was surveyed will have to be inserted, in order to bring the maps up to date.

96. The total cost of the party for the survey year was ₹94,043, and the cost-rates per square mile were as follows :—

	R	*a.*	*p.*
Triangulation	3	14	9
1-inch topography	20	5	11
Revision of topography in revenue surveys	9	3	6
Maymyo 16 inches to 1 mile topographical survey	842	10	2

The cost of the triangulation was very small indeed, owing to a great portion of the ground being cultivated, and the hills requiring no clearing. But the cost-rate of the 1-inch detail survey was slightly greater than that of the year before, because of the amount of jungle clearing required in the Ruby Mines district.

97. The programme for next field season is :—The triangulation of sheets 234, 235, 196, 195, 194, 193, 155, 156, 111, 112 ; the detail survey on the 1-inch scale of sheets 236, 237, and revision of portions of sheet 241 ; also the revision of topography in cadastral surveys in sheets 250, 249, (west half), 201, 200 and perhaps 199, 198 and 197.

The party was inspected by the Surveyor-General in September.*

* The officer in charge reports that Messrs. Serrao, Petters, and Byrne, and Sub-Surveyors Abdul Khalik, Sakhawat Husein, Sheikh Mohamed, and Sheikh Abdullah deserve special mention for the excellence of their work.

UPPER BURMA.

NO. 11 PARTY.

98. This party is one of the two which is employed on the topographical survey of the Shan States. The party left Bangalore in two sections, the portion to be employed on triangulation leaving a fortnight before the main body, under Mr. Doran, which left on the 2nd of November 1899.

Personnel.

Mr. P. J. W. Doran, Extra Assistant Superintendent 4th grade, in charge.
Mr. W. M. Kelly, Extra Assistant Superintendent, 5th grade.
Mr. H. G. Shaw, Sub-Assistant Superintendent, 1st grade.
Mr. B. M. Berrill, Sub-Assistant Superintendent, 3rd grade.
Babu Pramadaranjan Roy, Sub-Assistant Superintendent, 3rd grade.
Surveyors J. Sebastian, Ramsabad, and 12 Sub-Surveyors and Probationary Sub-Surveyors.
1 Writer.
1 Typer.

99. The strength of the party was about the same as in the previous year. This party has, as a rule for many years past contributed towards the supply of surveyors for special work and during the year under report Surveyors Mahmud Husain and Abdul Rahim and Sub-Surveyor Mowni Ram were employed on the Burma-China Boundary survey under Major Renny-Tailyour, R.E., and Sub-Surveyor Kudratulla under Captain Hare, R.E., on special survey work on the N. E. frontier.

100. Surveyor Mahmud Husain was permitted to retire from 1st August 1900. The party, by his retirement, loses a good hand. He has worked hard and willingly, and Government have recognised his services by bestowing on him the title of Khan Sahib. Babu Pramadaranjan Roy, Sub-Assistant Superintendent, was transferred from the Dehra Training School in place of Mr. P. White, who, having been declared unfit for further service, was allowed to retire on invalid pension. Surveyor Ramsabad rejoined the party on his return from Yunnan.

101. Owing to the unusual rains which swept over Burma in the early part of November, both sections of the party were considerably delayed. The main body was unable to leave Kyauksé where a temporary head-quarters had been established owing to a delay in the arrival of the transport, the wet state of the country and the swollen rivers obstructing the bullocks on their march down, and the triangulation party could not proceed for some time owing to the heavy state of the road to Taunggyi. The country surveyed in detail was, taken as a whole, very poorly populated, and as the locality was unable to meet the wants of the party, rations had to be arranged for for the men working in the less populated parts.

102. The country is wild and mountainous, the undergrowth in the valleys very thick, and as a rule damp during the colder months, rendering the country unhealthy. There was a fairly large number of cases of sickness under treatment during the season, and though every care was taken of the health of the men, two died and several went home on departmental leave with shattered constitutions due to malaria. Sub-Surveyor Rampershad, a very promising young hand, died early in June on his return home, and the deaths of some of the others have since been reported.

103. The programme for the season was the completion in detail of sheets 308 and 309 and western halves of sheets 354 and 355 and the triangulation of sheets Nos. 525 to 528 and the completion of the portions of sheets Nos. 456 and 457 left unfinished by Mr. White. The programme of detail survey was completed and the eastern halves of sheets 354 and 355 also surveyed. The work marked off for triangulation was also completed. The outturn of the party is as follows:—

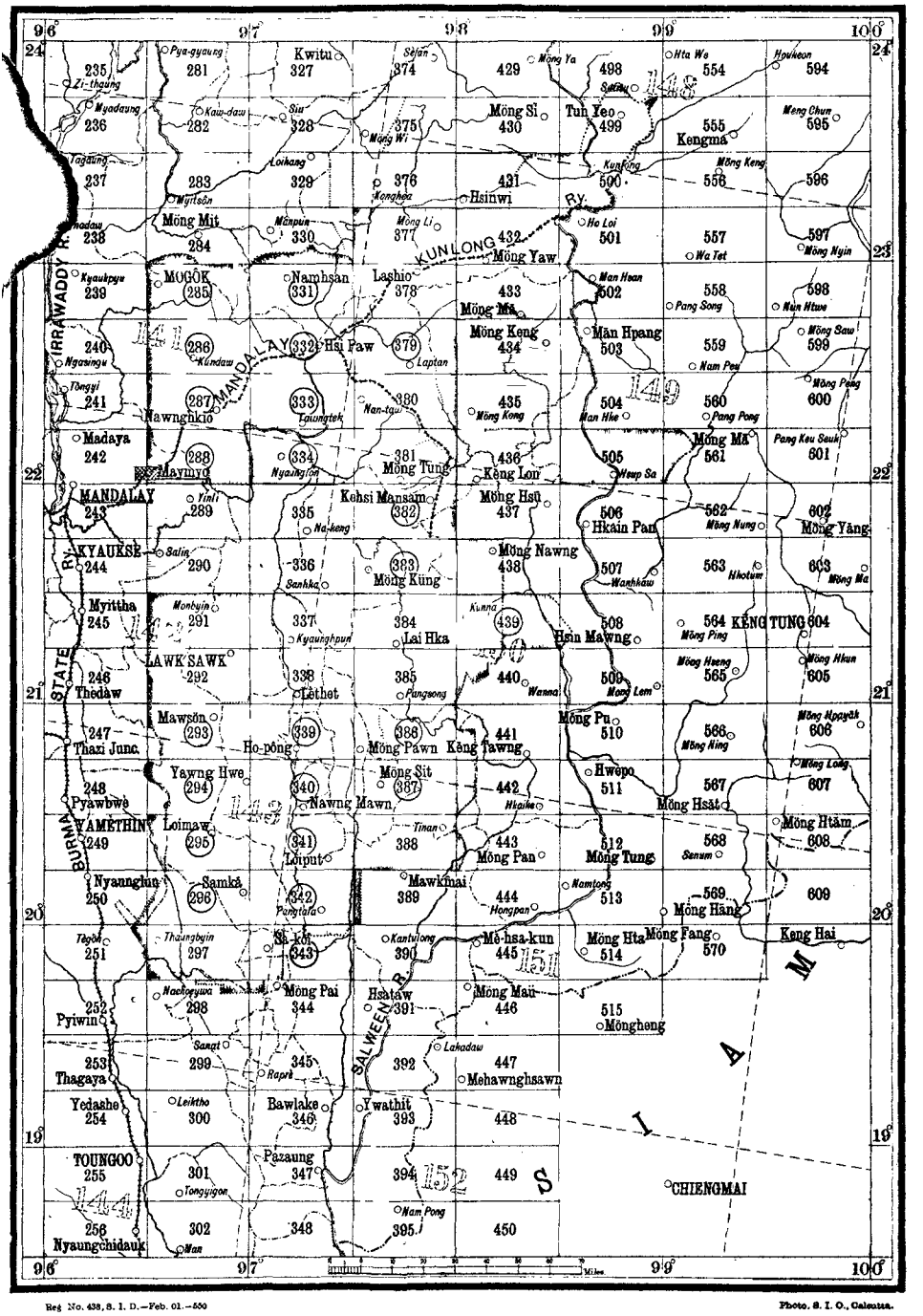
(*a*) Detail survey on 1-inch scale, 2,453 square miles (this includes an area of 242 square miles of overlap and about 70 square miles of re-survey).
(*b*) Triangulation for the 1-inch scale, 3,070 square miles.

The outturn both of topography and triangulation considering the nature of the ground is very satisfactory. The surveyors were visited regularly and the work after a rigorous test proved excellent.

UPPER BURMA SURVEY.

INDEX TO THE TOPOGRAPHICAL SURVEY IN UPPER BURMA & SHAN STATES.

1899-1900. Nos. 11 & 21 PARTIES.



Reg No. 438, S. I. D.—Feb. 01.—550

Photo. S. I. O., Calcutta.

NOTES.

The numerals **243**, &c., indicate the Standard sheets on the Scale of 1 Inch = 1 Mile.

The figures and lines in strokes represent the numbers and limits of the Engraved sheets of the Indian Atlas.

REFERENCES.

Sheets published are shown thus 340

Area previously Surveyed .....

.....Surveyed during 1899-1900 .....

.....Triangulated during previous seasons .....

.....do.....during 1899-1900 .....

Maymyo Survey, 16 Inches = 1 Mile, 1896-99 .....

No. 320-S. 01.

104. The total cost for the season, ₹87,418, is higher than it was last year. This excess is due to having to keep up permanent carriage during the whole season for the supply of rations to the men working in the less populated parts and a change in the transport used. Bullocks had to be substituted for carts to take the party out, and bullock transport is very expensive. The cost-rates are therefore somewhat higher.

Triangulation for the 1-inch survey, ₹11·1.

Detail survey on the 1-inch scale, ₹20·4.

105. The programme for next season is:—The detail survey of sheets Nos. 456, 457, 525 and 526 and the triangulation of sheets 459 to 462 and 529 to 531.

The Surveyor-General inspected the party on the 11th and 12th September, and expressed himself as quite satisfied with the state of the work.*

UPPER BURMA.

No. 21 PARTY.

106. This party was in charge of Mr. James at the beginning of the year. On the 25th October Captain Hare resumed charge on return from privilege leave, but as he proceeded on special duty from the 18th November 1899 to 24th August 1900, the charge devolved during his absence on Mr. Todd. Captain Hare again proceeded on privilege leave on the 26th September, and Mr. Hamer held charge up to the end of the year.

As in previous years Sub-Assistant Superintendent Ikbaluddin and one sub-surveyor were detailed with the Burma-China Boundary Commission. Surveyor Lachman Jadu and 3 sub-surveyors were placed under Captain Ryder for service in Yunnan. One sub-surveyor accompanied Captain Hare to the upper reaches of the Irrawaddy and Sub-Assistant Superintendent Ikbaluddin and the same sub-surveyor accompanied Major Renny-Tailyour to China in July 1900.

Personnel.

Captain C. H. D. Ryder, R.E., Officiating Deputy Superintendent, 1st grade, on special duty.

Captain H. J. Hare, R. E., Officiating Deputy Superintendent, 2nd grade, in charge from 25th October to 17th November 1899, and from 25th August to 25th September 1900.

Mr. C. F. Hamer, Extra Assistant Superintendent, 2nd grade, from 18th September.

Mr. A. J. James, Extra Assistant Superintendent, 2nd grade, in charge to 24th October 1899.

Mr. H. Todd, Extra Assistant Superintendent, 2nd grade, in charge from 18th November to 24th August 1900.

Mr. W. F. E. Adams, Sub-Assistant Superintendent, 1st grade.

Mr P. Williams, Sub-Assistant Superintendent, 2nd grade.

Ikbaluddin, Khan Sahib, Sub-Assistant Superintendent, 3rd grade.

Mr. S. S. McA'F. Fielding, Sub-Assistant Superintendent, 3rd grade.

Mr. P. A T. Kenny, Sub-Assistant Superintendent, 3rd grade.

Surveyors and Sub-Surveyors.

Lachman Jadu, Ganu Mal, Natha Singh, Muhammad Latif, Kudrat Ali, Jamna Pershad, Keshao Jadu, Abdul Gafur, Hazrat Ali, Permanand, Samshuddin and four Probationary and Apprentice Sub-Surveyors.

107. The party left recess quarters at Bangalore on 2nd November 1899; left Mandalay between 21st to 28th November and proceeded to Möng Yai the capital of Southern Hsinwi in the Northern Shan States, where the temporary head-quarters were established and returned to recess quarters on 1st June 1900.

108. Triangulation in advance and revision triangulation was carried out; the former in parts of sheets 329, 375, whole of 376 and 431, and the latter in parts of 432, 433 and 434. The detail survey of sheets 434, 435 and 436 and a small portion of 433 on the scale of 1 inch to a mile was completed. The proposed programme of the season was thus fully carried out, inclusive of the preliminary triangulation and theodolite traverses for the large scale (16 inches to a mile) survey of Hsi Paw town and environs.

109. The outturn of work is as follows:—

	Square miles.
Triangulation for 1-inch survey	1,535
Revision triangulation ,,	1,575
Triangulation for Hsi Paw (Thibaw)	81
Detail survey on the 1-inch scale	1,701
Reconnaissance survey in Yunnan ¼-inch scale	92,400

* Mr. Doran reports in very high terms of the work of all his European assistants, but specially singles out Mr. Kelly for his cheerful and willing assistance. Babu Roy for the first season has done well.

The surveyors and sub-surveyors with three exceptions are reported on favourably. Among the native staff, Hayat Muhammad is prominently brought forward.

110. The total cost of the party from 1st October 1899 to 30th September 1900 is ₹1,05,210, and the cost-rates *per* square mile are as follows :—

	₹	a.	p.
Triangulation for 1-inch survey	9	14	7
Detail survey „ 1-inch scale	17	12	2
Triangulation for Hsi Paw (Thibaw) 16-inch scale .	17	5	10

which figures compare favourably with last year's returns.

111. The health of the party was very good throughout the field season, there being no serious cases of illness and only a very few of ordinary intermittent fever.

112. The country surveyed in detail included parts of Kehsi Mānsām, Möng Hsū, Möng Nawng, and Kēng Lön in the Southern Shan States, and parts of Northern and Southern Hsinwi States, Möng Tung and Mang Lün in the Northern Shan States. The ground is all very hilly, and more or less covered with heavy tree and scrub jungle. The highest hill (Loi ling, 8,771 feet above sea level) in the Northern Shan States fell in the area surveyed during the season. On this hill indigenous tea trees are found, which attain the height of forest trees, and many of which have a diameter of a foot or more.

113. The programme for the coming season is to survey in detail on the 1-inch scale sheets 431, 432 and the unsurveyed portion of 433, the large scale survey (16 inches to a mile) of the town and environs of Hsi Paw (Thibaw) and to triangulate sheets 282, 283 and the untriangulated portions of 284, 328, 329, 330 and 375.

114. The Surveyor-General inspected the party on the 6th and 7th September 1900, and was quite satisfied with what he saw of maps, records, etc., of the party.

115. Captain Ryder was employed on special duty throughout the year on exploration surveys in China in company with Captain H. R. Davies of the Oxfordshire Light Infantry and Major Manifold, I. M. S. He also took with him 4 native surveyors from this party. Starting from Bhamo at the end of November 1899, the various members of the party travelled independently till early in April 1900, when they met at Atentzú in the extreme north of Yunnan, whence the native surveyors returned to Bhamo by way of the Mekong river. The rest made their way to Shanghai *viâ* Batáng and the Yangtse river, which they struck at Yachou, reaching Shanghai unharmed just after the recent outbreak of disturbances in China. The total area of reconnaissance surveys carried out by Captain Ryder and his companions on the $\frac{1}{4}$-inch scale is some 40,000 square miles.

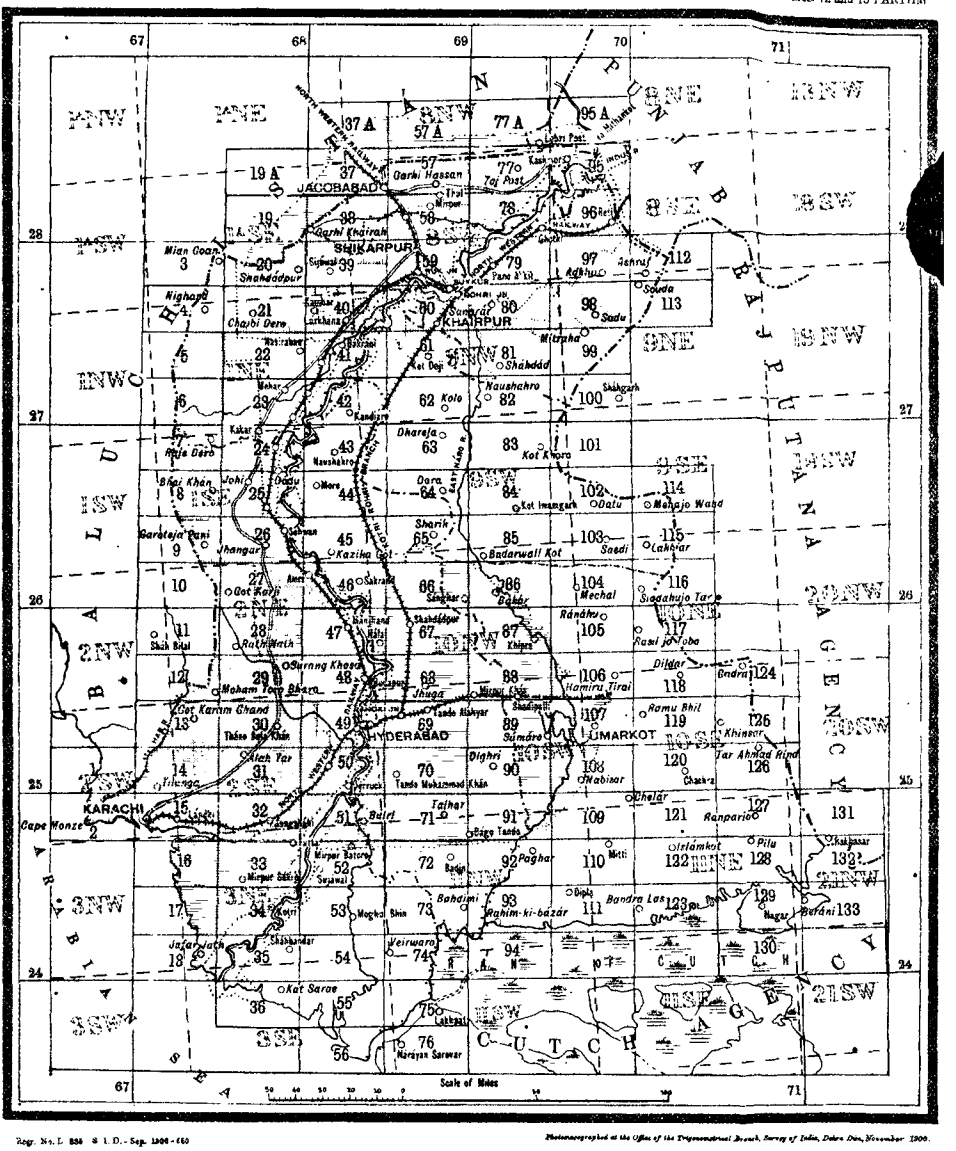
116. Captain Hare joined a military police expedition that was despatched from Myitkyina towards the end of November 1899 for the purpose of defining and mapping the watershed of the Salween and Nmai-kha rivers and tracing its connection with the Burma-Chinese boundary. Starting from a point on the Nmai-kha about 20 miles above its junction with the Irrawaddy, up to which it had already been mapped, he has made a reconnaissance survey on the scale of 4 miles to the inch of the Nmai-kha river for a distance of about 50 miles, including the whole of the basin on both sides. The area mapped is about 1,320 square miles. The expedition returned to Myitkyina about the middle of March having experienced very bad weather with constant rain and intense cold, some of the hills visited running to an altitude of 12,000 feet. Their movements were also much hampered by mule transport which necessitated a good deal of road making, and also to the fact that the probable attitude of the inhabitants had often to be ascertained before an advance was made. Unfortunately, no detailed report of Captain Hare's journey is forthcoming, as he fell ill in October 1900, while on leave, and died in Ceylon to the great regret of all who knew him.*

* The officer in charge reports that Messrs. Adams and Williams have rendered valuable assistance, and that Messrs. Fielding and Kenny did well in their first year. Of the surveyors and sub-surveyors the following are reported to have done well :—Lachman Jadu, Natha Singh, Kudrat Ali, Jamna Pershad, Keshao Jadu, Abdul Gafur, Hazrat Ali, Shamsuddin and Ramsaran.

1899-1900

SIND SURVEY.

Nos. 12 and 15 PARTIES


JACOBABAD
SHIKARPUR
KHAIRPUR
HYDERABAD
UMARKOT
KARACHI
Cape Monze
Scale of Miles
67
68
69
70
71
Mian Goan
Shahdadpur
Garhi Khairan
Taj Post
Ashruf
Sadu
Shahdad
Naushahro
Kot Diji
Kot Mohra
Kot Imamgarh
Mehajo Wand
Bhadarwali Kot
Saadi
Lahbiar
Siadahujo Tar
Ranahu
Mechal
Rasi jo Goba
Dildar
Bhadra
Hamiru Tirai
Ramu Bhit
Khinsar
Tar Ahmad Rind
Ghabisar
Chakar
Chelar
Ranpario
Islamkot
Pilu
Khabisar
Bandra Las
Bharani
Jhuga
Sumaro
Tando Mohammad Khan
Tando Allahyar
Tando Adam
Tando Ghulam Ali
Tando Jan Muhammad
Tando Muhammad Khan
Tando Jam
Tando Bago
Tando Ghulam Hyder
Tando Allahyar
Tando Mir Muhammad
Tando Jan Muhammad
Tando Ghulam Ali

SIND.

No. 12 Party.

117. The operations during the year under report were in continuation of those of the previous season. Mr. Barker held charge of the party up to 16th October 1899, on which date Mr. Erskine on his return from privilege leave resumed the charge, which he retained throughout the year.

Personnel.

Mr. C. F. Erskine, Deputy Superintendent, 1st grade, in charge from 16th October 1899.
Mr. J. A. Barker, Extra Assistant Superintendent, 3rd grade, in charge from 1st to 15th October 1899.
Mr. G. G. Vander-Reek, Extra Assistant Superintendent, 5th grade.
Mr. R. F. Warwick, Extra Assistant Superintendent, 6th grade.
Munshi Rahmatullah, Sub-Assistant Superintendent, 1st grade.
Mr. E C. J. Bond, " " 2nd "
Babu Dhani Ram, " " 3rd "
and 53 Sub-Surveyors, Computers and Draftsmen.

118. The following programme was completed:—

(*a*) A series of secondary triangulation, about 51 miles in length, as a check on traversing, and another of 27 miles in length to supply points for the Sind-Khairpur riverain frontier survey.
(*b*) Village boundary traverse survey in sheets Nos. 77, 78, 79, 95, 96 and portions of 60, 61, 80, 81, 82 and 97.
(*c*) Detail survey on the 2-inch scale of the whole area allotted to the party in sheets Nos. 19, 20, 21, 37, 38, 57 and also portions of 39, 40 and 58.
(*d*) A survey on the 4-inch scale of the Sind-Khairpur riverain frontier.

The recess office at Karáchi closed on the 25th October and the party reassembled at Sukkur in the Shikárpur district on 1st November 1899.

119. The traversing consists of a village boundary survey with offsets, and the area traversed is 2,250 square miles. There were 12 main circuits measured, 14 sub-circuits, and 434 village circuits. The angular work was checked by observations for azimuth at 108 stations on main and sub-circuits, the angular error *per* station being 0·5″. The linear measurements amounted to 3,128 miles, and were checked by 39 connections with principal stations of the Great Indus Series, and with stations of the secondary triangulation executed by the party. The average correction being 1·4 links per 1,000. No permanent marks were laid down at traverse stations, but every fifth station has been marked by an earthen pillar, and wherever practicable the boundary stones embedded by the Revenue authorities have been utilised, and the positions of other marks on the village boundaries have been fixed by offsets.

The cost of the traverse survey amounts to ₹14 per square mile, which includes triangulation.

120. The area surveyed in detail on the 2-inch scale is 2,383 square miles, and this was mapped in 75 plane-table sections. It comprises the whole of the area allotted to this party in sheets 19, 20, 21, 37, 38, 57 and also portions of 39, 40 and 58. Detail survey was carried out entirely by interpolation, and was based mainly on the traversing. It was tested from 1,126 *in situ* fixings and was done under the direct supervision of the officer in charge and three assistants. The cost of detail survey is ₹10 per square mile.

121. The country surveyed was of the same description as that dealt with in former years, the only hilly portion being situated in sheets 20 and 21 beyond the limit allotted to this party. Except in the western part of sheets 20 and 21, where the cultivators are to a great extent dependent on the water from hill streams for irrigating purposes, the country was well populated and well watered and numerous well built villages were met with. The large towns of Jacobabad, Shahdádpur, Kumbar and Lárkhána fell within the area surveyed, of which Jacobabad is a military cantonment and the head-quarters of the Upper Sind Frontier district.

122. In consequence of the many disputes arising from the constant changes in the course of the Indus, an agreement was entered into between the Government and His Highness the Mir of Khairpur, whereby the cold weather deep stream channel of 1899-1900 was in future to be observed as the boundary between Sind and the Khairpur State and a portion of the State on which the Jamrao Canal works have been erected, together with certain lands situated on

either bank of the Nára river, were to be ceded by His Highness the Mir to the British Government. This involved the resurvey of the ground in the vicinity of the old Sind-Khairpur boundary, and in accordance with instructions received the survey was undertaken on the 4-inch scale.

123. The traverse survey of this area was commenced in December 1899 and the area traversed is 425 square miles. There were 4 main traverses: the outer and inner traverses were connected in 6 places and cross observations, from both sides of the river, along which the inner traverses ran, were taken in 6 places. The angular work was checked by observations for azimuth at 22 stations on outer and inner traverses, the angular error *per* station being 1·09″. The linear measurements amounted to 561 miles and were checked by five connections with stations of the Great Indus Series, and with stations of the secondary triangulation executed by the party. The average correction being 1·6 links *per* 1,000. The total number of traverse stations observed at on the outer and inner traverses is 681.

The connecting lines 41 in number, starting from the outer traverse on the left bank of the river, intersect each bend of the deep stream channel and are finally closed on the outer traverse on the right bank. They are to be permanently demarcated at their extremities, which will be carried out next field season, and the nature of the marks embedded will then be described.

The detail survey was commenced in March 1900, and was carried out partly by interpolation, and partly with the chain, and was fully tested.

124. In connection with the area ceded by His Highness the Mir of Khairpur, in the vicinity of the Jamrao canal works, a traverse defining the limits of the land ceded was run, starting from Dinganwári station of the Eastern Sind Secondary Series, and closing on Khánatar H. S. of the same series. The area traversed is 180 square miles. The angular work was checked by observations for azimuth at five stations, the angular error *per* station being 1·30″. The linear measurements amounted to 58 miles, and were checked by two connections with stations of above mentioned series of triangulation, the average correction being 1·9 links per 1,000.

The description of the marks demarcating the new line of boundary is as follows. Twenty-two marks consisting of masonry pillars 1 foot 6 inches square and 6 feet in height will be built. These will be founded on a cube of masonry 2 feet square. In each pillar will be embedded a 10 feet iron rail of which 6 feet will project above the masonry.

125. During the field season there was little or no sickness, but on returning to Karáchi the assistant writer and one *khalási* succumbed to plague.

Field work closed in the middle of April, and the party returned to Karáchi for recess. During recess the entire area surveyed in detail was fair mapped with the exception of part of sheet No. 58, which will be drawn next year when the survey is completed. The mapping was comprised in 32 quarter sheets of which 5 were blank, and they have been despatched to the Trigonometrical Branch Office for publication. Sheets Nos. 20 and 21 have been drawn as far as surveyed by this party, the remainder of these sheets will be drawn by No 15 Party.

126. The triangulation and traverse charts of sheets Nos. 77, 78, 79, 95 and 96 have been drawn. All these charts with their lists of co-ordinates were despatched to Dehra Dún at the close of the season. The charts of sheets Nos. 80, 81, 97, 98 and 99 have been drawn, but will be held over until the ½-inch work falling in these sheets is completed.

127. Next season triangulation and traversing in advance will be taken up throughout the Khairpur State. Detail survey will be carried on in sheets Nos. 39, 40, 58, 59, 77, 78 and 95.

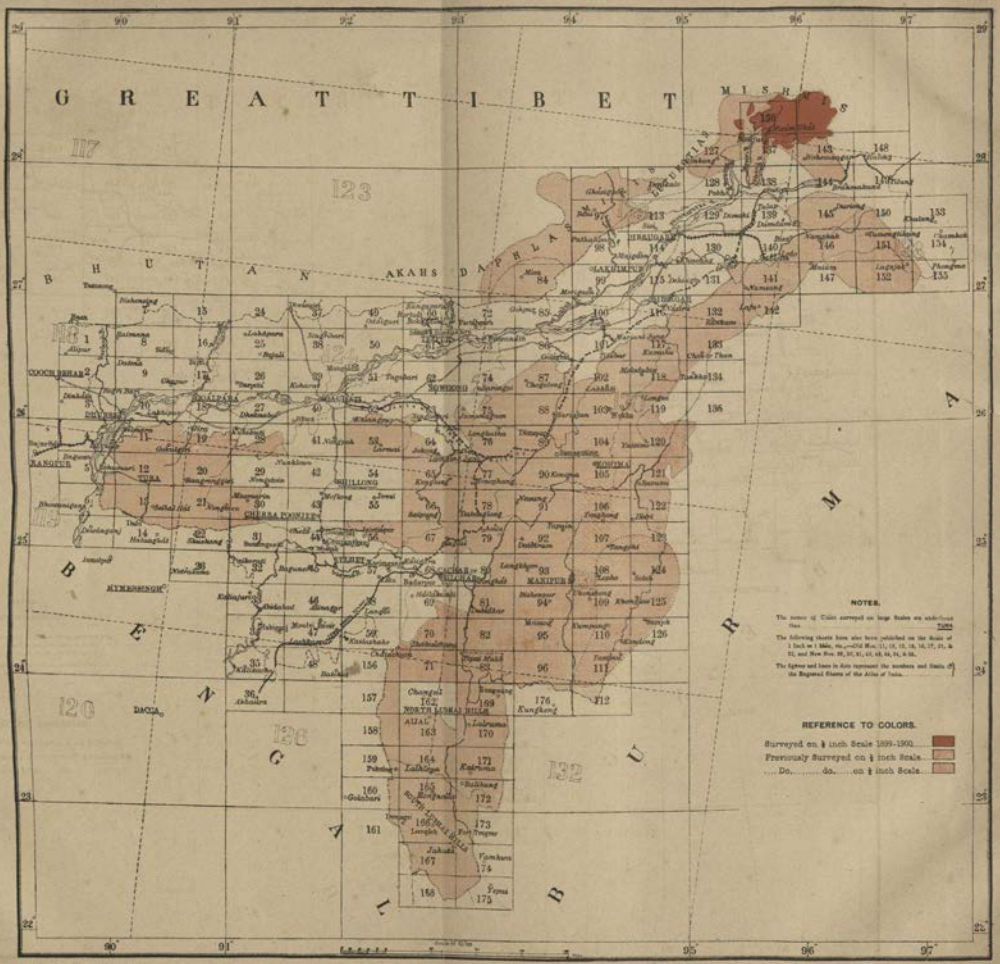
The party was inspected in October 1899 by Colonel Gore, Surveyor-General, who expressed himself satisfied with the work done.*

* Mr. Erskine reports well of all his assistants, specially mentioning Mr. Warwick, and that the whole native establishment, with two exceptions, gave satisfaction, but Ram Kinker Pershad, Ishar Singh, Gurmukh Singh, Maula Bakhsh, Muhammad Akbar, and Lal Behari Lal are particularly deserving of mention.

ASSAM SURVEY.

INDEX MAP SHOWING RECONNAISSANCE SURVEYS ON 1 INCH & 1 INCH SCALES.

1899-1900.



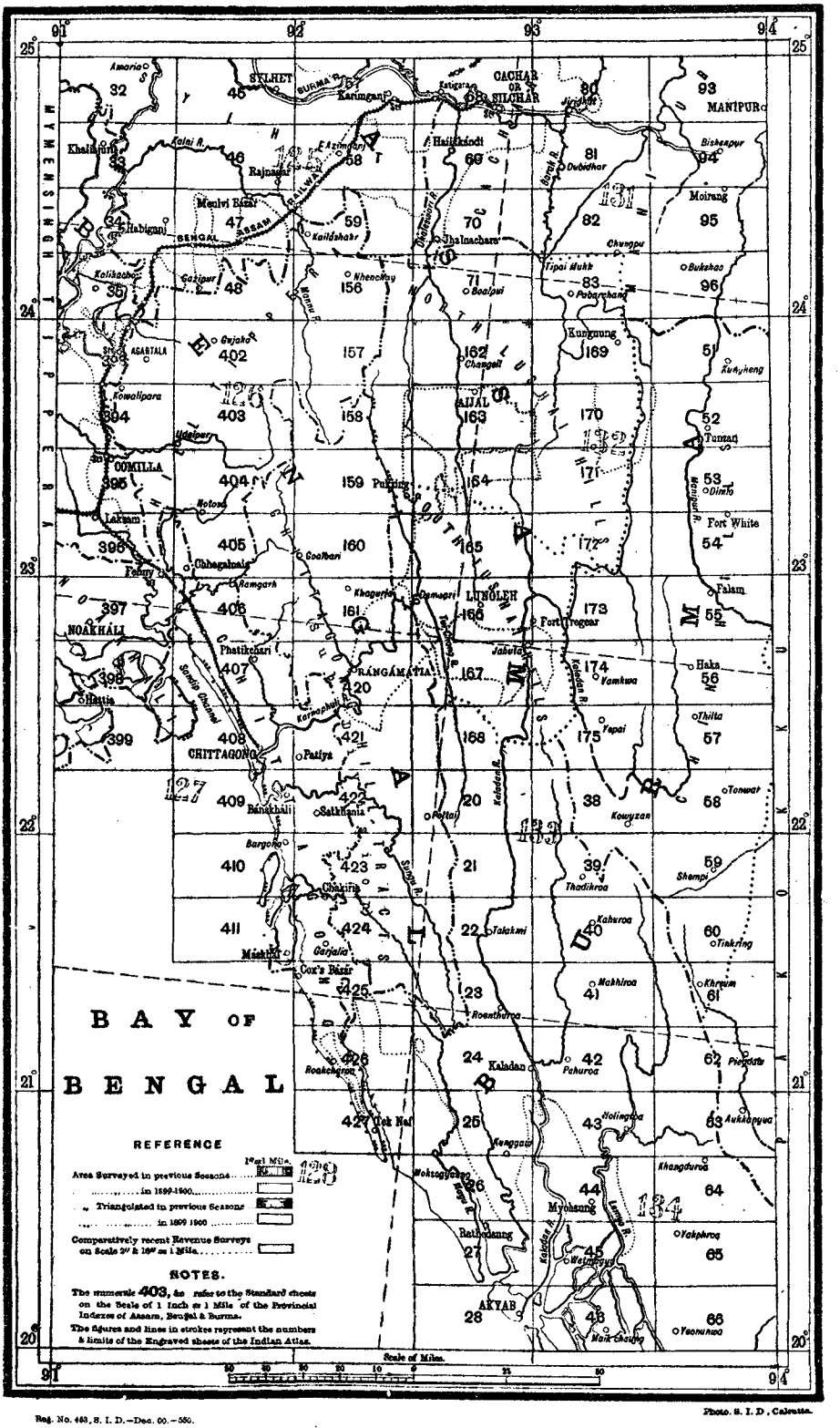
Reg. No. 4, S. I. D.—Feb. 01.—650.

Photo. S. I. O., Calcutta.

No. 318-S. 01.

INDEX TO THE TOPOGL. SURVEY OF THE LUSHAI HILLS.

1899-1900. - No. 14 PARTY



Reg. No. 443, S. I. D.—Dec. 00.—550.

Photo. S. I. D., Calcutta.

No. 629-S. 00.

LUSHAI HILLS, ASSAM.

No. 14 PARTY.

Personnel.

Captain C. L. Robertson, R.E., Deputy Superintendent, 1st grade, in charge from 1st October to 8th November 1899 and from 17th March 1900.

Mr. R. Waller-Senior, Extra Assistant Superintendent, 6th grade, in charge from 9th November 1899 to 16th March 1900.

Sub-Surveyors, etc.

Ram Singh, Mahadeo Daji, and 11 others.

128. Captain Robertson, with the exception of the period during which he was on field service as survey officer with the Mishmi Expedition, held charge of the party throughout the year under report. He was absent on this duty from 9th November 1899 to 16th March 1900. During his absence Mr. Waller-Senior held temporary charge.

129. The party left recess quarters in Shillong on 23rd October 1899, and, with the exception of one native surveyor, who was detailed to carry on the net work of tertiary triangulation in the South Lushai Hills and who proceeded to his ground *viâ* Chittagong and Rangamátia, travelled to the field *viâ* Goalundo and Silchár. The field season was closed by 12th April and the whole party returned to Shillong by the same route as that by which the majority had taken [illegible]. The recess office was opened on 10th May 1900.

The continuation of the net work of tertiary triangulation carried out in [illegible] was the only class of this kind of work executed this season. As [illegible] year it was based on a side of the first class secondary series run [illegible] values of which in final terms were received from the com- [illegible], during the year under report. The work lay in sheets 166 [illegible] and 171 though, owing to the failure of the triangulator employed [illegible] latter area to close his observations on a side of known value, it has not [illegible] been possible to compute out his work.

As regards topography, the detail survey on the scale of 1 inch=1 mile of sheet 163 was completed, and of a portion of sheet 164, while at the beginning of the season a survey on the ½-inch scale of a portion of the Manipur-Lushai border was carried out, and towards the end, one on a scale of 24 inches=1 mile of Aijal station.

131. In addition to this a detachment, consisting of Captain Robertson, with Sub-Surveyor Dharmu and 16 menials accompanied a military expedition proceeding against the wild Mishmi tribe beyond the extreme north-east frontier of the province. The detachment was absent from the party for nearly four and a half months and was able to carry on survey operations for just two months, during which time 808 square miles of ½-inch topography were completed. The difficulties and hardships experienced were considerable, both on account of the extremely mountainous and densely wooded nature of the country and the great severity of the climate, as well as of the fact that, owing to the military exigencies of the expedition, no tents and none but the lightest scale of baggage could be carried. All the country visited was surveyed, much of it having never before been explored, but bad weather prevented the extension of the survey over the more distant country as well as the execution of triangulation by which the positions of important peaks lying to the northward in districts which appear blank in the existing maps, might have been fixed. A detailed account will be found in the appendix.

132. The outturn for the season was as follows :—

	Square miles.
Tertiary triangulation (net work)	787
Reconnaissance in advance of tertiary triangulation	343
Detail survey on 1-inch scale	759
Reconnaissance on ½-inch „	808
Do. on ¼-inch „	344
Survey of Aijal station on the 24-inch scale	

133. The cost-rates of these different classes of survey have worked out as under :—

	Per square mile. *R*	*a.*	*p.*
Tertiary triangulation	28	5	9
Reconnaissance in advance of tertiary triangulation	14	2	10
Detail survey on 1-inch scale	55	6	4

As the net work triangulation on which the detail survey of sheet 163 has this year been based, is partly that executed in 1897-98, at a cost-rate of ₹50 *per* square mile, and partly that of the following season costing ₹31-13-4 *per* square mile, and as, further, a portion of the 1-inch detail survey of this sheet was done during the season previous to that under report, at a cost-rate of ₹64-6-9 *per* square mile, a mean cost-rate based on the proportional areas of the surveys of the different seasons included in this standard sheet has been accepted for both triangulation and detail topography, giving a final cost-rate for sheet 163, of ₹96-15-10 *per* square mile. This rate is probably fairly representative of that for the survey of future seasons.

134. The health of the party during the field season under report has not been good, though, owing to the number of imported coolies being less than half of that of the preceding season, and to the fact that there was no cholera epidemic among them as was the case then, the actual number of cases of deaths and diseases has been greatly reduced. Every care was taken of the health of the men and the unsatisfactory state of affairs in this respect is attributable only to the unhealthiness of the country and to the hardship inseparable from service in it.

135. The country surveyed and the difficulties of survey are similar to those described in the report on last year's operations. As in previous years coolie transport was employed exclusively and some 180 Gurkha coolies were imported for the purpose, an innovation being made in the employment of Lushai coolies to bring up the transport to the strength required. This arrangement was found to work satisfactorily, and provided a sufficient number of Gurkha coolies are procurable, will be repeated next season.

Rations for all men, brought into the country with the party from [illegible], with the exception of a proportion of the rice, as heretofore, to be imported, and the supply was done by the same man who had in previous years held the contract. The supply was satisfactory, and the same man has again been offered the contract for the ensuing season.

136. The programme for next season will include the completion of the network of tertiary triangulation in sheet 170, commenced during the past season, and its extension southwards over sheet 171 and part of 172. The completion of the remaining portions of sheet 164, and of the whole of 165 will be also undertaken on the scale of 1 inch=1 mile. It is possible also that a survey on the $\frac{1}{4}$-inch scale of a portion of the Lushai boundary on the north may again be asked for by the Superintendent, Lushai Hills, but as no definite orders have as yet issued on the subject no provision for the execution of the work has been made in the programme.*

NORTH-WESTERN FRONTIER.

No. 15 Party.

137. Colonel Wahab held charge of the party throughout the year. Lieutenant Crookshank, who had recently been appointed to the department, joined on the 16th November, and Messrs. Freeman and Anderson who replaced Messrs. Tate and Petters transferred elsewhere, joined the party at the commencement of the field season.

Personnel.

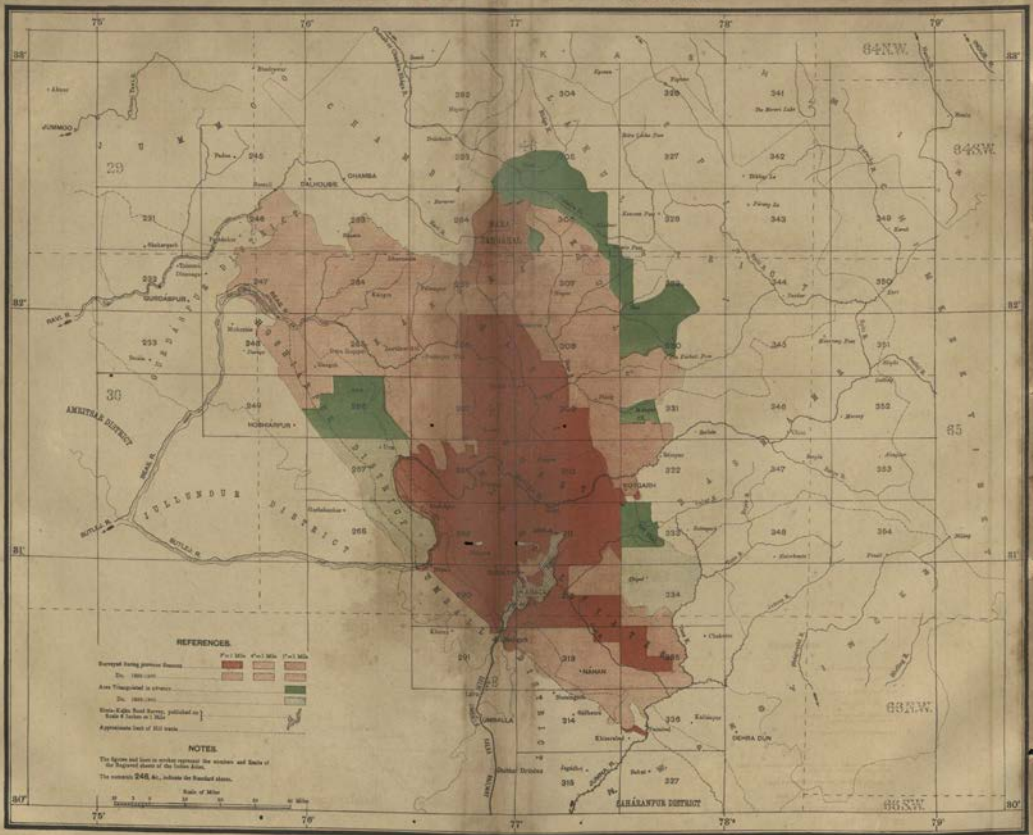
Colonel R. A. Wahab, C.I.E., R.E., Superintendent, 1st grade, in charge.
Lieutenant G. A. Beazeley, R.E., Officiating Deputy Superintendent, 2nd grade.
Lieutenant A. A. Crookshank, R.E., Officiating Assistant Superintendent, 1st grade.
Mr. E. A. Wainright, Extra Assistant Superintendent, 3rd grade.
Mr. G. A. Knight, Extra Assistant Superintendent, 5th grade.
Yusuf Sharif, Khan Bahadur, Sub-Assistant Superintendent, 1st grade.
Mr. J. A. Freeman, Sub-Assistant Superintendent, 1st grade.
Babu Amar Singh, " " 2nd "
Mr. H. C. H. Cooper, " " " "
" P. R. Anderson, " " " "
Ahmed Ali Khan, Khan Bahadur, Sub-Assistant Superintendent, 2nd grade.
Six Surveyors, 16 Sub-Surveyors, 2 Soldier-Surveyors, 7 Draftsmen and Typer, 2 Computers and 2 Writers.

138. The detachments working in the plains left recess quarters on the 20th October and returned between the 1st and 8th April;

* The Officer in charge reports that Mr. Waller-Senior managed the party satisfactorily while he held temporary charge. The other members have all worked cheerfully under exceptionally trying conditions. Sub-Surveyors Surjan Singh, Mahdeo Daji, Hayat Muhammad Khan, and Sita Ram deserve special mention.

PUNJAB SURVEY

INDEX TO THE SURVEY OPERATIONS IN THE HIMALAYAS



No. 254-S. 00

Capt. G. A. Beazeley, photo.

Photogravure, Survey of India Offices, Calcutta. January 1901.

THE KISHANGANGA AT SHARDI.

the Kashmir detachment was at work in the field from the end of May to the end of September.

139. The party was divided into the following detachments:—One for Secunderabad under Mr. Freeman, another under Mr. Knight for Ráwalpindi and Attock, and a third under Lieutenant Beazeley for the Kashmir survey; during the winter this detachment together with several draftsmen was employed under Mr. Wainright in fair mapping. A small detachment under Mr. Cooper was occupied in traverse surveys for revenue purposes in Balúchistán.

140. The programme of the Secunderabad detachment included the survey of the various separate cantonments composing Secunderabad and Bolarum on the scale of 12-inches to a mile. The whole of this was completed and the fair maps, 10 sheets, drawn during the recess. In Kashmir the programme included the continuation of regular survey on the $\frac{1}{2}$ inch scale in Chilas, Astor, and the Kishanganga valley, the extension of triangulation along the Indus valley between Chilas and Bunji, and the 2-inch survey of the road between Chitral and Gilghit, part of which was done last year. This has been carried out with the exception of the triangulation which, owing to the extremely difficult nature of the country, has only been partly done. Observations were taken at 11 stations, and six more, all of which have been selected, remain to be observed at next season. In Sind no detail survey was carried on, all available surveyors being required for the Secunderabad work; the triangulation proposed in sheets 47, 48, and 49 was however completed.

141. During the recess the maps of the whole of the area surveyed during the year in Secunderabad have been drawn and are now ready for publication. The computations of the triangulation executed during the year and of Mr. Tate's Balúchistán work of 1898 occupied Mr. Knight and three computers throughout the recess.

142. The outturn of work was as follows:—

	Square miles.
Triangulation for $\frac{1}{2}$-inch survey	1,000
" " 1-inch "	980
" " 12-inch "	53
Detail survey on $\frac{1}{2}$-inch scale	3,256
" " 1-inch "	87
" " 2-inch "	331
" " 6-inch "	22
Contour " 6-inch " (contouring only)	199
Detail " 12-inch "	46
Reconnaissance Surveys, $\frac{1}{4}$ and $\frac{1}{8}$-inch scales	27,515

143. The programme for the ensuing season includes the extension of detail survey in Sind on the 1-inch scale during the cold weather; the Kashmir detachment will resume work in the hot weather in the Gilghit Agency.

The office of the party was inspected by the Surveyor-General at Mussooree on the 25th July.*

HIMALAYAS, PUNJAB.

No. 18 Party.

144. Mr. Potter was in charge of the party up to the 1st January 1900, when Major Bythell returned from leave and resumed charge.

Personnel.

Major W. J. Bythell, R. E., Deputy Superintendent, 1st grade, in charge from 2nd January 1900.
Lieutenant C. P. Gunter, R. E., Assistant Superintendent, 2nd grade, from 2nd January to 3rd September 1900.
Mr. C. D. Potter, Extra Assistant Superintendent, 3rd grade, in charge up to 1st January 1900.
Mr. W. Robert, Extra Assistant Superintendent, 4th grade.
" G. E. Parker, " " " 4th grade.
" J. O. Greiff, Sub-Assistant Superintendent, 1st "
" W. M. Gorman, " " 2nd "
" E. J. Biggie, " " " "
" C. E. C. French, " " " " to 15th May 1900.
Twenty-six Sub-Surveyors, 1 Writer and 23 others.

Lieutenant Gunter was posted to the party on 2nd January, and left on transfer to No. 14 Party on 4th September 1900.

Mr. French was placed on deputation to the Punjab Government for employment on the Simla boundary survey on the 15th May.

* The officer in charge reports favourably on the work of all the assistants, especially Messrs. Wainright, Knight, Freeman, and Cooper, who were in charge of detachments; and of Hussain Bukhsh, Jafar Ali, Kadir Sharif, Gopal Singh and Lal Singh.

145. As in previous seasons, the party was divided into detachments for work in various portions of the Himalayas. The detachments left and returned to recess quarters at times varying with the climatic conditions, the description of work and nature of the ground to be surveyed.

The following were the detachments:—

(*i*) For commencing the 1-inch survey of high ground on either bank of the Sainj and Tirthan *nálas* in Kullu, and continuing the 4-inch survey of the reserved forests in that area.

(*ii*) For work in continuation of that of the previous seasons in the Sirmúr State forests on the 2-inch scale.

(*iii*) For work in the Simla Hill States and Kángra.

(*iv*) For work in the Dasúya and Una *tahsils* of the Hoshiárpur district.

(*v*) Two triangulators, for continuing the triangulation in the Hoshiárpur district and Simla Hill States.

146. The Kullu detachment, consisting of Messrs. Gorman, Biggie and French, with two sub-surveyors, left Simla on 25th August, and was employed in Kullu until the beginning of December, when the two former assistants commenced triangulation in the Hoshiárpur district in sheets 289 and 287, respectively. The area surveyed lay along the valleys of the Sainj and Tirthan *nálas* and the high ranges to the north and south of these rivers. The highest peaks ranged from 15,000 to 21,000 feet above sea-level, and the ground generally was extremely rugged and precipitous. The duration of this detachment's field season was just over nine months.

147. The Sirmúr detachment under Mr. Potter, with seven sub-surveyors, completed the survey and classification of the State forests on the 2-inch scale. The *locale* of the season's operations lay on the high spurs running north-west and south-east of the Chor peaks (whose highest point reaches to 11,980 feet) and the ground bordering the Tons river and lying between that river and the Giri. The detachment returned to Simla during the end of May and beginning of June. The fair sheets of the survey on the 48-inch scale of Náhan town and cantonment were completed in the drawing section during the winter, and forwarded for publication at the end of May.

148. The Simla Hill States detachment under Mr. Robert,—to which Lieutenant Gunter was attached,—with eight sub-surveyors, left recess quarters on the 7th November and continued its previous season's survey on the 2-inch scale of a portion of the Kahlúr and Mandi States and of the Hamirpur *tahsil* of the Kángra district. The country surveyed consisted of low alluvial eminences, composed of a clay soil and rounded pebbles, mixed with conglomerate rocks. These hills have a bleak and barren aspect viewed from a distance, their sides are often bare and precipitous and sparsely covered with vegetation. But the valleys between them are fertile, thickly covered with hamlets and villages and highly cultivated. This detachment completed rather more than its allotted programme, and returned to recess quarters on 10th May, after a field season of just six months.

149. The Hoshiárpur detachment under Mr. Greiff, with six sub-surveyors and two soldier-surveyors, took the field on the 23rd November, and commenced 2-inch work in the Dasúya *tahsil* of the Hoshiárpur district, in the low-lying hills of the Katárdhar range, which stretches, from Rúpar on the Sutlej in a north-westerly direction to Hájipur near the Beas. These hills of low *Siwálik* formation presented considerable difficulties to the sub-surveyors, most of whom were new to 2-inch survey. With the exception of the bamboo forest reserves of Nandpur and Bindraban at the extreme north-west of the season's work, the range is entirely bare of vegetation or covered only with stunted scrub. It is seamed and cut up with innumerable water-courses, whose sides, often a hundred to two hundred feet in depth, are absolutely sheer. These ravines alternate with the "*Chos*" broad dry river beds of sand or large waterworn stones which fall steeply from the summits of the range and attain a considerable width as they approach the plains. The district was last year almost waterless owing to the failure of the year's rains. The detachment returned to recess quarters during the third week of May.

150. The triangulation in advance of topography in the Hoshiárpur district was completed by Messrs. Gorman and Biggie in sheets 268, 289 and 287 respectively. On the completion of his work in this district, Mr. Gorman moved into sheets 333 and 334, and completed the triangulation in the Hill States of Jubbal and Taroch.

151. As usual, the Drawing Section under Mr. Parker, with 22 draftsmen and apprentices, remained in Simla during the field season, and carried on the mapping work of the party.

152. The operations of the party were carried out in accordance with the sanctioned programme, the only deviations therefrom being the following:—

Mr. Robert did not visit Kullu in the spring owing to the exceptionally heavy snowfall in that district during the early months of the year.

The 2-inch survey of sheet 287 N. W. was taken up and completed by Mr. Robert's detachment, instead of that in sheets 289 N. W. and S. W.

The outturn of the field season's work amounted to the following:—

	Square miles.
Triangulation	693·0
Detail survey of the Sirmúr forests on 2-inch scale, with classification of forest growths.	308·8
Detail survey on 2-inch scale in Kahlúr and Mandi States and Kángra and Hoshiárpur districts.	655·0
Detail survey on 1-inch scale in Kullu Sub-division of Kángra district.	168·0
Forest surveys on 4-inch scale	107·7
Detailed surveys on all scales	1,239·5

The corresponding figures for last year were—

Triangulation	315
Detailed surveys on all scales	778

showing a very considerable increase for the year under report.

The total forest area surveyed on all scales, and included in the above, amounts to 425·9 square miles comprised in 197 blocks.

153. The cost-rate per square mile for each description of work is as follows:—

	₹
For triangulation	18·5
For 4-inch surveys	60·2
For 2-inch surveys in Sirmúr	45·6
For 2-inch surveys in the Simla Hill States, Kángra and Hoshiárpur	49·3
For 1-inch surveys in Kullu	45·6

154. Considerable progress was made in the fair mapping during the year under report. Twenty-eight sheets were sent for publication, and 49 proofs were examined and coloured. Eighteen sheets of forest classification were prepared for ferrotype reproductions, and were coloured and despatched to district officers. With the exception of three or four sheets in Kullu, which are held back for revision during the current field season, all the 4-inch sheets of the party's work have been sent for publication, and there are only the above arrears of work on this scale. The arrears on the 2-inch scale comprise some 16 sheets, of which six are in an advanced condition, and it is hoped that during the coming field season a considerable number of these will be cleared off, Mr. Potter having received an extension of six months' service from the 17th August with a view to supervising the drawing section during the winter months, and expediting the despatch for publication of the sheets in arrear.

155. Two soldier-surveyors have been under instruction during the year, *viz.*, Sepoy Manna Singh, 5th Punjab Infantry, and Naik Zarin Shah, 6th Punjab Infantry. The former completes his two years' course early in October.

There have been no further calls on the party during the year for subsurveyors for exploration duties. Garjman Rai rejoined on 21st December 1899 from survey duty with the Pekin Syndicate. The death of Ram Saran, an old and experienced sub-surveyor of the party, whilst on deputation in East Africa, has been reported.

156. *The Simla Boundary Survey.*—As soon as orders were received regarding the commencement of the Simla boundary survey, Mr. Greiff was directed to start the preliminary triangulation necessary to provide fixed points which should serve as initial and closing stations of the main traverses and prevent these from being of undue length.

The general scheme of the operations was, after providing a considerable number of carefully triangulated points to serve as check points, to run a series of main traverses (14 in number) along the principal roads. Minor or sub-traverses were then to be run along the smaller roads, the initial and closing points of the latter being stations of the main traverses. Finally, the boundaries of each holding or property were to be traversed and the position of the boundary pillars accurately determined, the stations of the main or sub-traverses being used, as convenient, as initial and closing stations. The external boundary of the municipality was also to be traversed, and connected. The work was to be plotted on the scale of 50 feet to the inch.

157. Mr. French was directed to undertake the main traverses, and, after some preliminary instruction in traversing by Messrs. Potter and Parker, he commenced the work early in January, and had completed the fourteen traverses by the 15th May, when he was placed on deputation under the Deputy Commissioner of Simla. Four sub-surveyors were transferred from No. 12 Party early in the year, and were employed continuously on the traversing of the minor roads up till the end of July, when the rains stopped work. By this time, with one or two exceptions, all the roads in Simla had been traversed, the outturn amounting to 48·4 linear miles of traverse, with 1,825 stations. The average angular error amounts to 3″ per station, and the linear error to 0·5 links per thousand.

A computer was also transferred from Nos. 2 and 8 Parties, and all the traverses have been set up and proved. A draftsman from No. 12 Party joined during August, and is now engaged in plotting the traverses, a work of some magnitude, as the survey will be comprised in about 70 sheets.

Since his deputation Mr. French has been employed on the demarcation and verification of boundaries throughout Simla, and when this work is completed (probably early next year), the actual boundary traverses will be commenced.

A survey of Viceregal Lodge on the scale of 48 inches to the mile based on the Simla traverses was also completed during the field season.

158. The programme for next field season provides for the completion of the 1-inch detail survey in Kullu and of that on the 2-inch scale in the Hoshiárpur and Kángra districts in sheets 266, 267, 268 and 289. No triangulation will be undertaken, this class of work being now complete, and the Hill States of Jubbal and Taroch having been triangulated in advance. The coming field season will thus see the completion of the original programme of the party's operations in the Himalayas, with the exception of the survey of Láhul and Spiti and of a small area of 1-inch survey in the Hill States of Jubbal and Taroch.

159. To meet the various requirements of the Punjab Government, it has been decided to reorganise this party. The present Punjab traverse detachment will be amalgamated with No. 18 Party, which will then be composed of :—

(*a*) A traverse section, to take up such traverses as may be from time to time required by the local Government or for providing data for standard maps.

(*b*) A riverain survey section, which will be employed on work required by the Punjab Government.

(*c*) A map revision and compilation section, which will deal with the compilation of topographical maps from the *patwáris'* settlement maps and their revision on the ground when necessary.

(*d*) A small topographical section, which will complete the topographical survey of the Hill States and such other work of that nature that may be necessary.

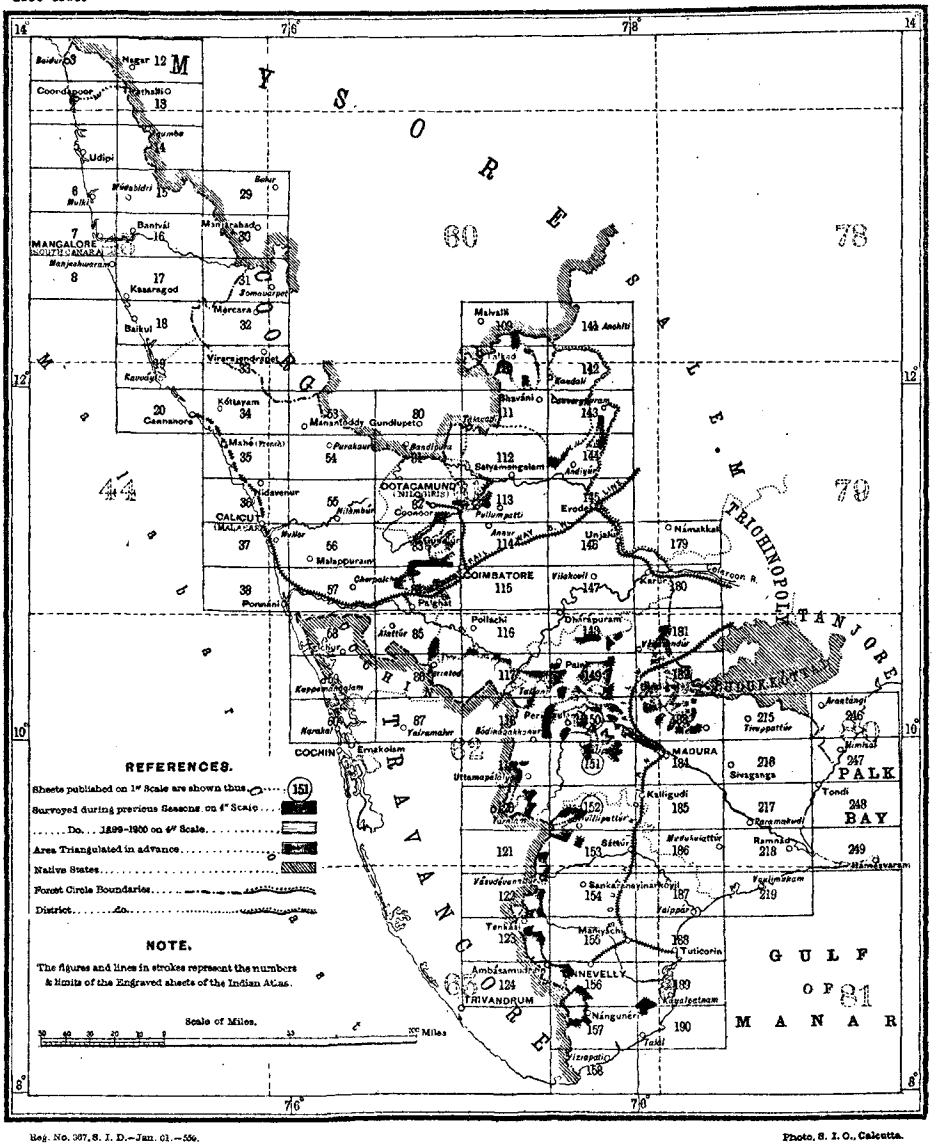
160. The recess office of the party was inspected on the 30th May and 10th July by the Surveyor-General, and on the 14th and 15th August by the Superintendent, Trigonometrical Surveys, who expressed themselves pleased with the condition and administration of the party.*

* The officer in charge reports well of the work of all the asisstants: of the Native Establishment, the following are specially brought to notice: Paras Ram, Sheopal Misar, Amba Dutt, Bhamba Ram, Narain Dutt, and the Writer Amir Singh.

MADRAS SURVEY.

INDEX TO THE FOREST SURVEYS IN THE SOUTHERN CIRCLE.

1899-1900. Nos. 9 & 19 PARTIES.



Reg. No. 307, S. I. D.—Jan. 01.—550.

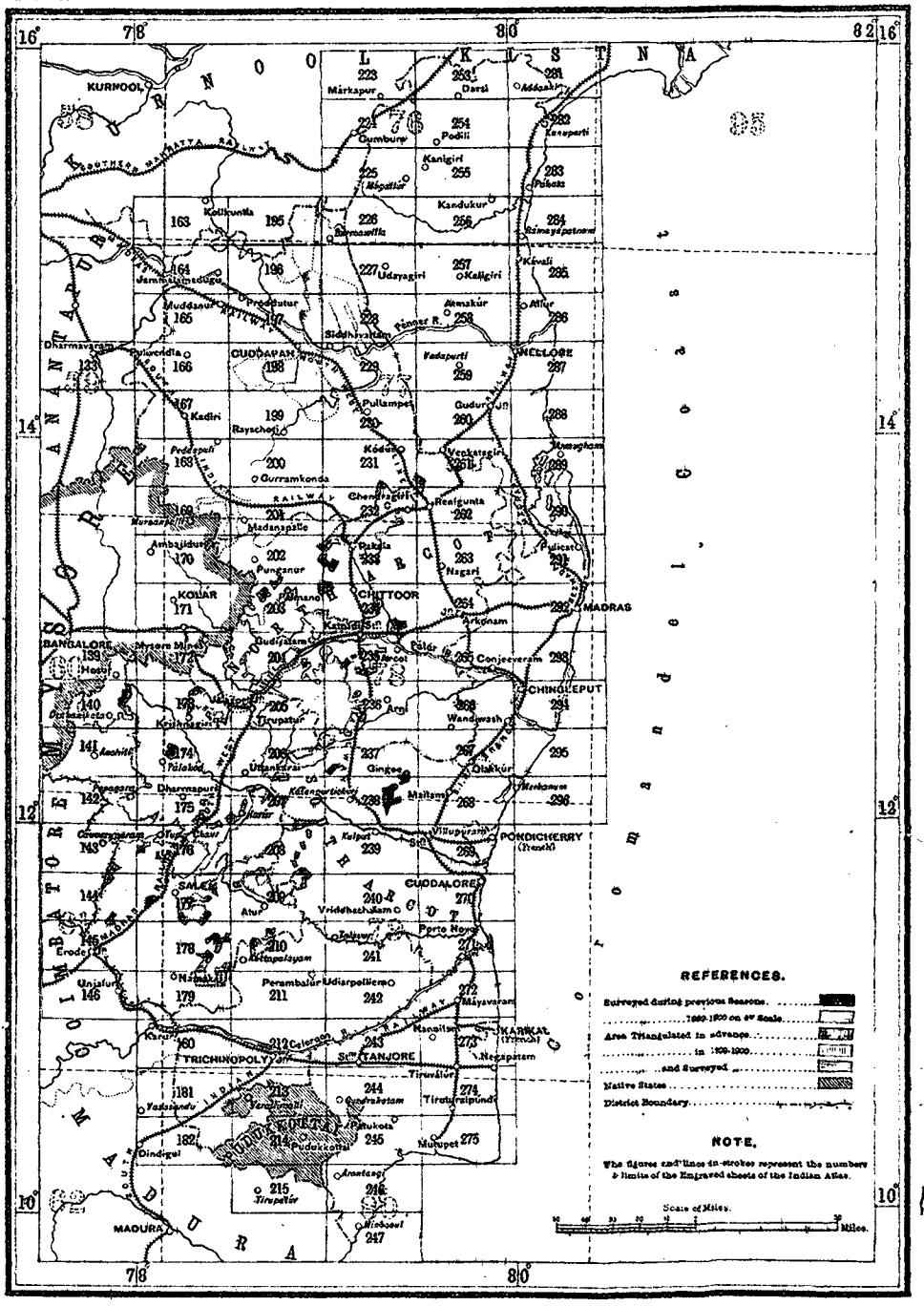
Photo. S. I. O., Calcutta.

No. 304-S. 01.

MADRAS SURVEY.

INDEX TO THE FOREST SURVEYS IN THE CENTRAL CIRCLE.

1899-1900 Nos 9 & 19 PARTIES



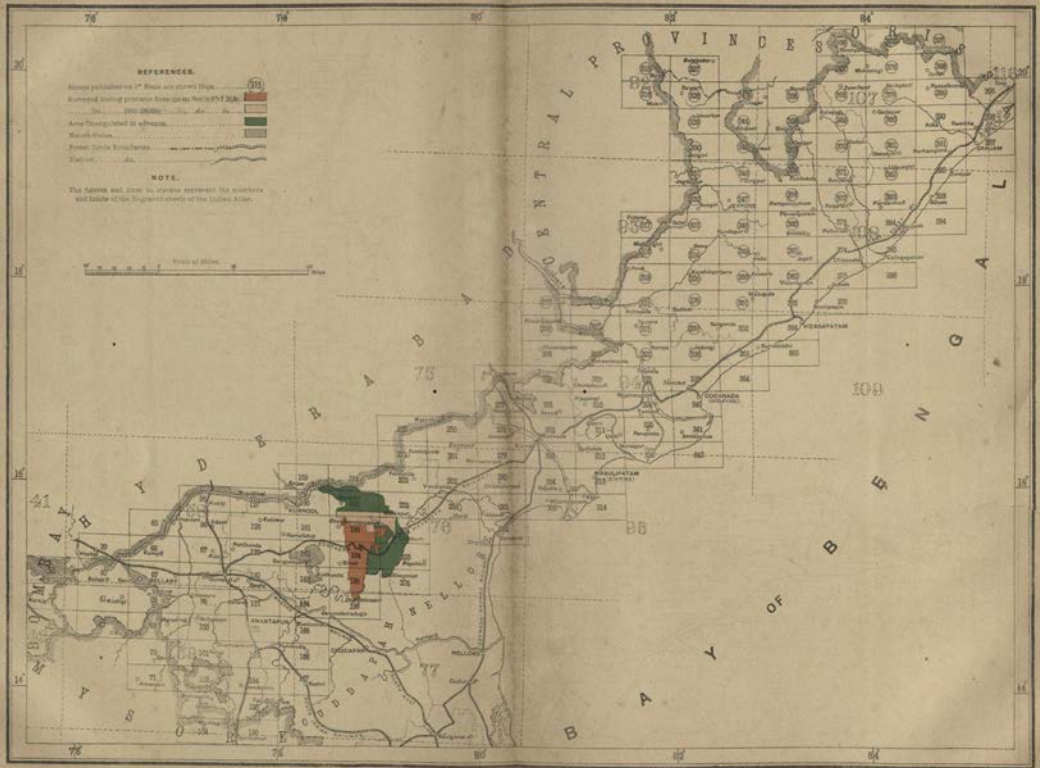
Reg: No 44., S. I. D.—Jan. 01.—650.

Photo. S. I. O., Calcutta.

No. 309-S. 01.

MADRAS SURVEY.

1899-1900. INDEX TO THE FOREST SURVEYS IN THE NORTHERN CIRCLE. Nos. 9 & 19 PARTIES.



Reg. No. 307, S. I. D.—Dec. 30.—1900.

Form, S. I. D., Calcutta.

No. 822-S. 00.

FOREST SURVEYS.

MADRAS PRESIDENCY.

NOS. 9 AND 19 PARTIES.

161. Captain Hume held charge of the parties throughout the field season, and Captains Pirrie and Hare, and Mr. Hugh Todd during the recess. The first detachment left Bangalore for the field on the 6th October 1899 and the last to return from the field did not reach Bangalore till the 22nd May 1900. To obviate arrears of work in office, the dates of departure of the several camps had to be extended over a month and more and, to allow of a full six months field season, the return of detachments had, necessarily, to be fixed for different dates.

Personnel.

Captain A. H. B. Hume, R.E., Officiating Deputy Superintendent, 2nd grade, in charge up to 17th May.
Captain F. W. Pirrie, I.S.C., Deputy Superintendent, 2nd grade, in charge from 18th May to 18th June.
Captain H. J. Hare, R.E., Officiating Deputy Superintendent, 2nd grade, in charge from 19th June to 22nd August.
Mr. H. Todd, Extra Assistant Superintendent, 2nd grade, in charge from 23rd August.
Lieutenant E. T. Rich, R.E., Assistant Superintendent, 2nd grade, from 29th November 1899 to 17th August 1900.
Mr. C. F. Hamer, Extra Assistant Superintendent, 2nd grade, up to 17th September 1900.
Mr. R. Todd, Extra Assistant Superintendent, 3rd grade, up to 11th July.
Mr. G. T. Hall, Extra Assistant Superintendent, 4th grade, from 1st January.
Mr. J. H. S. Wilson, Sub-Assistant Superintendent, 2nd grade.
Mr. M. J. Sheehan, do. do., 2nd grade.
Babu Jagdamba Pershad, do do., 2nd grade, from 19th October 1899 to 23rd January 1900.
Sixty Surveyors, Sub-Surveyors, Apprentices and Soldier-Surveyors, and 1 Writer.

162. The parties were worked on much the same lines as in previous seasons, *viz.*, by camps. Each camp being placed under the immediate control of an officer of the Provincial service, who was held responsible for its supervision and discipline. The officers in charge of camps were Mr. Wilson in Kurnool, Mr. R. Todd in Cuddapah, Mr. Hamer assisted by Mr. Sheehan in Coimbatore and Mr Hall in South Kánara.

163. In the Cuddapah district an area of 630 square miles of triangulation was carried out by Mr. Sheehan and Sub-Surveyor Hillaluddin. The triangulation for the Madanapalle forest reserves, done by Mr. Sheehan, was also computed by him in the field with a view to completing the detail survey before the close of the field season. In the Coimbatore district, the reconnaissance for triangulation was completed during the previous season and the observations held over, two successive triangulators having been completely incapacitated by fever. These observations were now entrusted to Surveyor Govindraju and extended over an area of 407 square miles. This completes the triangulation required in the district. In the South Kánara district the triangulation was commenced, and an area of 392 square miles completed by Mr. Hall assisted by Sub-Surveyor Eknath Battu. The smaller outturn compared with other districts is due to Mr. Hall having joined two months after the parties had taken the field, also to the difficulty in procuring labour from distant villages. No triangulation was done in the Kurnool district there being a sufficiency for two seasons in advance.

164. Traversing of forest reserve boundaries was carried on in the Cuddapah, Coimbatore and South Kánara districts, and a total of 312 linear miles completed.

165. The area topographically surveyed on the 4-inch scale in the districts of Kurnool, Cuddapah and Coimbatore amounts to 1,524 square miles, the largest yet recorded as executed by the combined parties in a single season and 324 square miles over and above the original programme. The work was examined by the officer in charge from time to time and, more in detail by each of the camp officers, except in the case of Mr. Hamer who was physically unfit for the work, this duty devolving on Mr. Sheehan, his assistant.

166. There is little to add to the description already given in previous reports as to the general character and physical aspects of the country surveyed. The extreme eastern slopes of the Nallamalais in Kurnool, abutting the cultivated areas in the plains, proved more open, less forest clad, and hence easier to survey than in previous seasons. To this fact may be attributed, in some mea-

sure, the larger outturn of work. In the South Kánara district the western slopes of the Mysore plateau, for a descent of 3,000 feet were clad with dense forest, and being far removed from all habitation, presented many difficulties to the surveyor, whereas the country between these slopes and the coast consisted mostly of low hills, sparsely forest clad and therefore more accessible.

167. The season proved an exceptionally healthy one, though there were a few sporadic cases of fever. The N.-E. monsoon having practically failed, the weather throughout was particularly dry and conducive to health. No deaths were recorded.

168. During recess the computations have been brought up as far as practicable. The work of the native triangulators entailed great loss of time and proved most laborious. More attention will be paid to the training of these men in future. The fair mapping of 60 sheets was carried out, inclusive of eight sheets that were partially finished during the previous season. Of these 60 sheets, only 22 can be submitted for publication, the balance have to be withheld for resurvey of certain boundaries wrongly demarcated by the Forest officials, and the location of shrines and limits of "enclosures" that were found omitted subsequent to survey.

169. The actual cost, including cost of instruments, for the survey year ending 30th September 1900 is R1,07,631-10-2 or an average of R70-12-5 *per* square mile. The following table shows the cost-rates and area surveyed for the last three years :—

Description of work.	Cost-rates per square mile.			Area surveyed in square miles.		
	1897-98.	1898-99.	1899-1900.	1897-98.	1898-99.	1899-1900.
	R	*R*	*R*			
Triangulation . .	10·6	14·0	8·4	3,331	950	1,429
Traversing . .	17·0(*b*)	15·3(*b*)	27·4(*b*)	712 (*a*)	598 (*a*)	312 (*a*)
Topography . .	78·0	58·1	58·1	1,050	1,350	1,524

(*a*) Linear miles.
(*b*) *Per* Linear mile.

To reduce the cost-rates as much as possible during the ensuing season the triangulation will be carried on entirely by native agency, under the supervision, as far as practicable, of the respective camp officers, and it is considered that, with more practice and a stricter enforcement of orders, better results will be attained than heretofore.

170. The programme for the ensuing field season comprises the continuation of triangulation, traversing of forest boundaries, and 4-inch topography in the Kurnool and Cuddapah districts; completion of topography and traversing in the Coimbatore district; and the continuation of triangulation and traversing and commencement of topography in the South Kánara district.

The increasing yearly outturn of topography has a tendency to be carried beyond the limits compatible with efficiency. The sanctioned programme has, invariably, been exceeded. In some instances quality has suffered at the expense of quantity, and work, on examination, has had to be rejected. The individual members have been worked at high pressure and all leave during recess, unless on medical certificate, has had to be refused. Steps have been taken to check this tendency to excessive outturn.

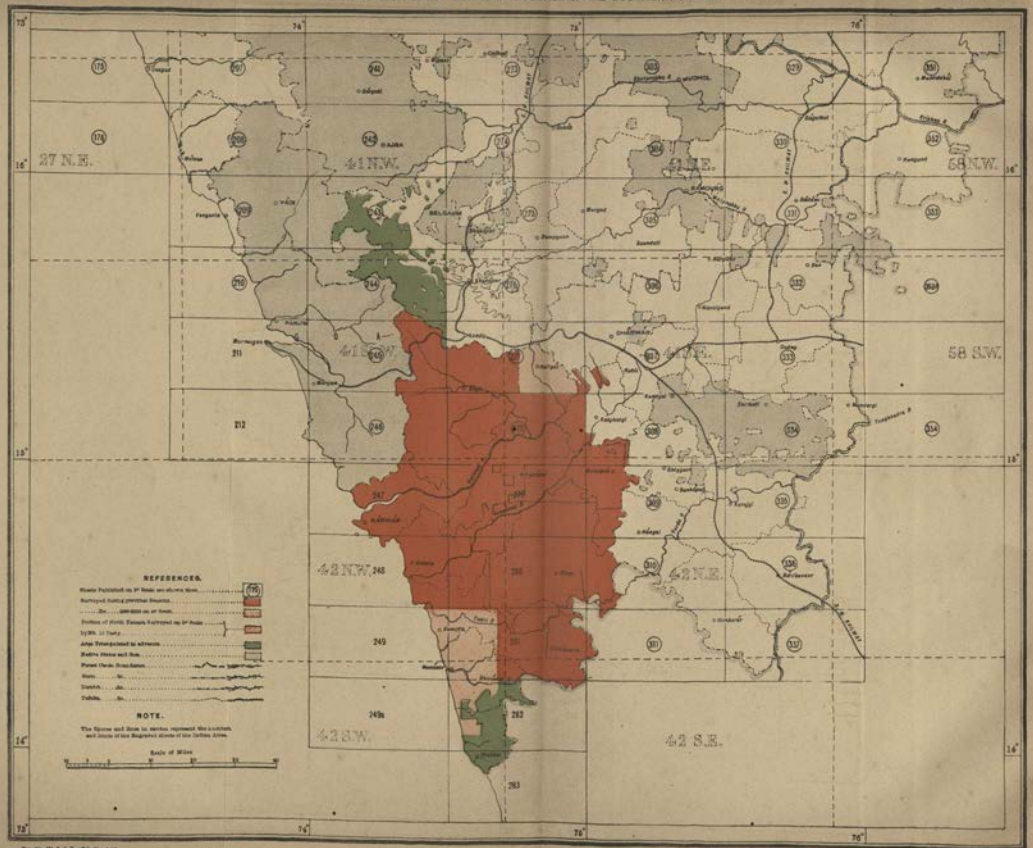
171. The parties were inspected by the Deputy Surveyor-General in July and by the Surveyor-General in September. The district Forest officers of Kurnool, Cuddapah and Coimbatore visited the office at Bangalore during

1899-1900.

BOMBAY SURVEY.

INDEX TO THE FOREST SURVEYS IN PORTION OF THE SOUTHERN CIRCLE.

No. 17 PARTY.



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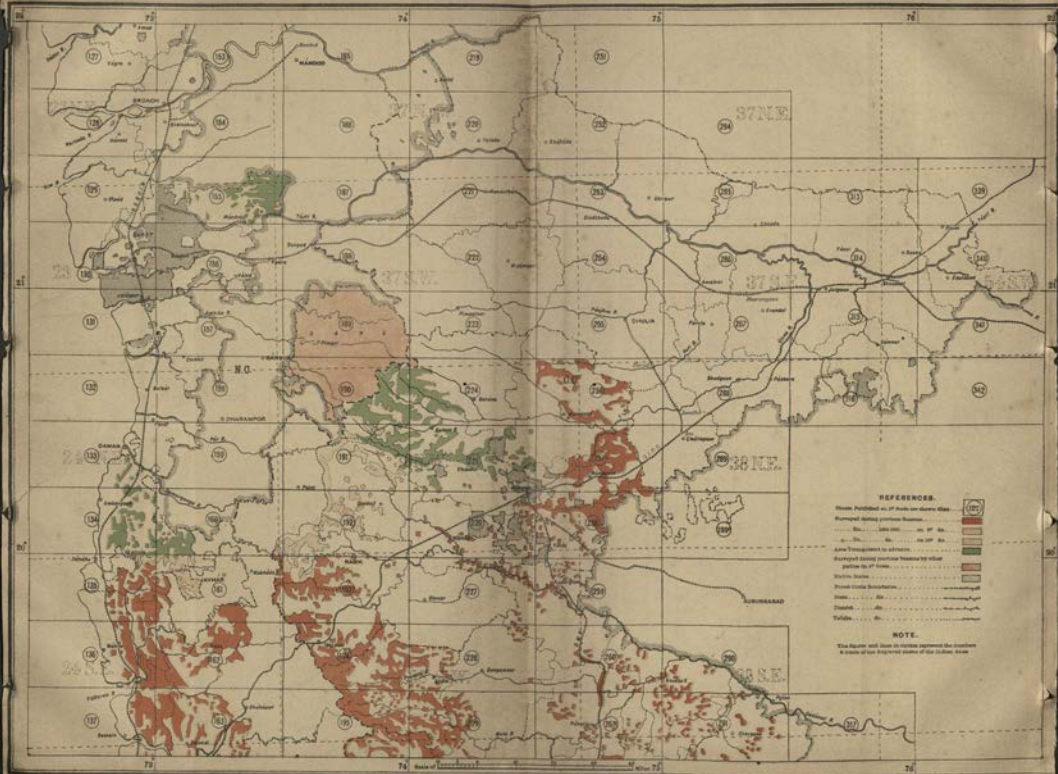
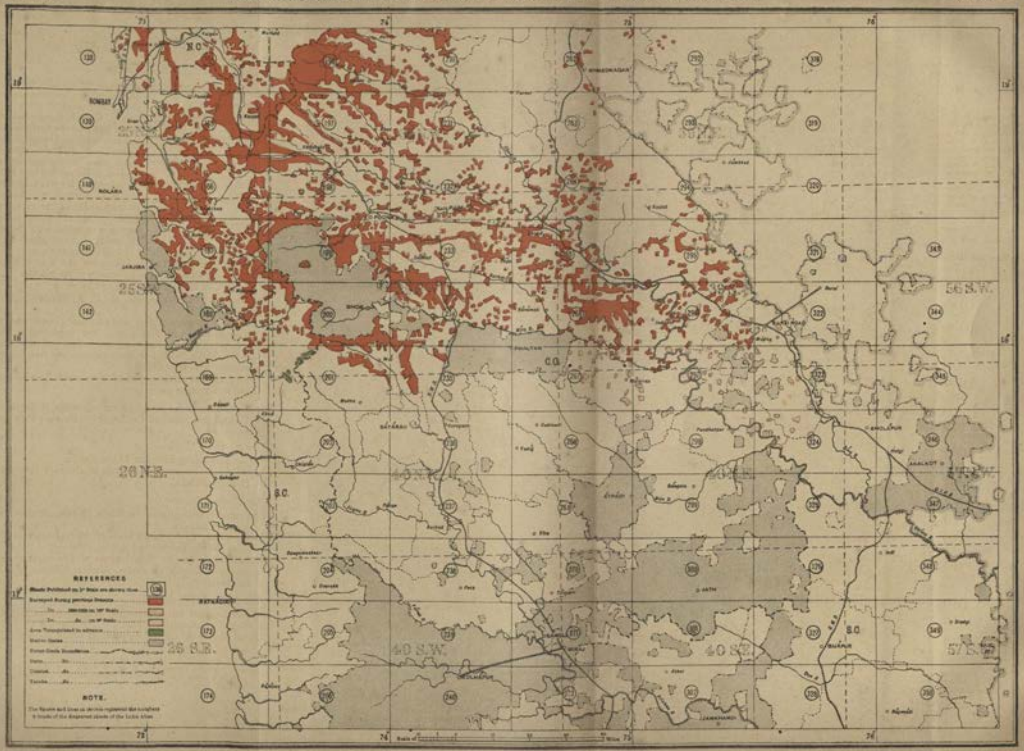
BOMBAY SURVEY.

1899-1900. INDEX TO THE FOREST SURVEYS IN PORTIONS OF THE NORTHERN & CENTRAL CIRCLES. No. 17 PART.



BOMBAY SURVEY.

1899-1900. INDEX TO THE FOREST SURVEYS IN PORTIONS OF THE NORTHERN, CENTRAL, & SOUTHERN CIRCLES. No. 17 PART.



No. 215-S. GI.

recess, for the purpose of examining the original plane-table sections with a view to rectifying errors before the fair maps were drawn.*

BOMBAY PRESIDENCY.

NO. 17 PARTY.

172. Mr. Tapsell held charge of the party until the 13th November 1899, when he retired on superannuation pension after a service of 36 years in the department. Captain Gordon resumed charge of the party on the 14th November 1899 and continued in charge during the field season and until the 17th September 1900, when he was appointed Superintendent of Forest Surveys in the Bengal Presidency. He was then succeeded by Mr. S. F. Norman, who held charge for the remainder of the survey year. Mr. Veale joined the party since the last report was submitted. Surveyor G. R. Bhopatkar retired after 25 years service and draftsman Ganesh Balal died of plague during the year.

Personnel.

Captain P. J. Gordon, I.S.C., Deputy Superintendent, 1st grade, in charge from 14th November 1899 to 17th September 1900.

Mr. C. E. Tapsell, Extra Assistant Superintendent, 2nd grade, in charge from 1st October to 13th November 1899.

Mr. S. F. Norman, Extra Assistant Superintendent, 5th grade, in charge from 18th to 30th September 1900.

Mr C. A. Norman, Extra Assistant Superintendent, 5th grade.

Mr. C. J. Veale, Sub-Assistant Superintendent, 2nd grade.

Surveyors and Sub-Surveyors.

R. V. Joshi, Govind Gopal, and 38 others.

173. The various detachments left Poona for the field in November and returned early in June, giving a full working season of six months.

The party was divided into the following camps:—

(1) consisting of 12 surveyors under Mr. C. A. Norman in North Kánara district.

(2) consisting of 17 plane-tablers and one triangulator under Mr. S. F. Norman, worked in Násik until the beginning of March, when Mr. Norman with 11 surveyors proceeded to Thána district, leaving Mr. Veale with five plane-tablers and one triangulator to continue the work in Násik.

(3) consisting of four to seven plane-tablers under Sub-Surveyor Govind Gopal in Sholápur district.

174. The party continued the survey, on various scales, of the forest reserves in the Northern, Central and Southern Circles of the Bombay Presidency; these operations comprising:—

(1) *In the Northern Circle—*

(*a*) Preliminary triangulation in Thána district.

(*b*) Detail survey on the 8-inch scale of the teak reserves in Thána (Dáhánu *táluka*).

(2) *In the Central Circle—*

(*a*) Preliminary triangulation in Násik (Násik, Dindori, Kalvan and Báglán *tálukas*).

(*b*) Detail survey on the 8-inch scale of the teak reserves in Násik district (Násik, Dindori and Kalvan *tálukas*).

(*c*) Detail survey on the 16-inch scale of the *bábul* reserves in the Sholápur district (Karmála, Mádha, Málsiras and Pandharpur *tálukas*).

(3) *In the Southern Circle—*

(*a*) Traversing and triangulation in Belgaum district (Khánápur and Belgaum *tálukas*).

(*b*) Detail survey on the 4-inch scale of North Kánara (Honávar and Kumta *tálukas*).

* The officer in charge commends the energy of Messrs. R. Todd, Hall, Wilson, and Sheehan. The subordinate establishment, with some exceptions, is also well reported on. Writer Tara Prosonno Roy managed his duties efficiently.

175. The following table shows in detail the cost-rates and the outturn for the year under report and the two previous years :—

Description of Survey.	Outturn.			Cost rates.		
	1897-98.	1898-99.	1899-1900.	1897-98.	1898-99.	1899-1900.
	S. miles.	S. miles.	S. miles.	R	R	R
Triangulation . . .	255	230	542	19·2	18·3	17·6
Topography 4-inch . .	444	429	379	49·4	53·2	64·18
„ 8 „ . .	204	254	236	155·7	136·6	139·51
„ 16 „ . .	29	55	55	176·3	122·9	134·10

The outturn of triangulation is more than double that of last year while the 16-inch detail survey is the same and that of 4-inch and 8-inch detail surveys is less by some six and 12 per cent. respectively.

The cost-rate of triangulation is slightly less than that of last year while those of detail survey are in all cases in excess. The reason for this increase will be considered further on.

176. To obtain a just comparison of rates and outturn the following statement showing the result for the year under report and four previous years has been prepared. In it, it has been assumed that one square mile of completed 8-inch or 16-inch survey is equal to $2\frac{1}{2}$ square miles of 4-inch survey (the normal scale of the party). The figures include preliminary traverse and triangulation, actual survey, fair mapping and all supervision :—

Year.	Number of Units.	Cost per Unit.	Total cost for Survey year.
			R a. p.
1895-96	1,137	68	77,368 2 8
1896-97	1,024·5	80·8	82,818 4 11
1897-98	1,026·3	64·4	66,106 8 9
1898-99	1,201·1	58·5	70,265 6 9
1899-1900	1,107	65·6	72,571 7 10
Average for 5 years	1,099	67·5	73,825 15 10

The results of the present season's work although quite up to the average do not appear so favourable as those of last year. The difference, however, is more apparent than real, and is, to a great extent, due to the unequal incidence of the charge for supervision as will be seen from the statement below, in which the results for the periods covered by the forest years, which include the same field season for the year as the previous table, are compared. The results, except for the exceptional year 1896-97, are very uniform. It is true that the

outturn for 1899-1900, is some eight per cent. less than for last year, and the cost rates consequently greater, although only by four per cent :—

Year.	Number of Units.	Cost per Unit.	Total cost for Forest year.
			R a. p.
1895-96	1,137	68	77,173 2 11
1896-97	1,024·5	80	81,656 1 1
1897-98	1,026·3	65	67,030 1 5
1898-99	1,201·1	61·5	73,889 6 4
1899-1900	1,107	63·8	70,702 6 8
Average for 5 years	1,099	67·7	74,090 3 8

177. The season has been an unfortunate one for many reasons: an unforeseen charge for grain compensation during the forest year added R3,051-15-1 to the total cost and in itself explains the above increase in cost rates; excluding this amount from the total cost the rates for the present year are even less than those for 1898-99, which so far have been the best on record for the party. The many casualties which have occurred during the last few years among the most efficient members of the party from plague and other causes have prevented the increase to the outturn which might have been reasonably expected, and it is a matter of congratulation that the results both as regards cost and outturn are as satisfactory as they are. Since the field season of 1898-99 the party has lost the services of three thoroughly trained men from plague and the senior and best surveyor in the party has been invalided. Every effort is being made to fill up these gaps, and apprentices are being trained both in the party and at the Dehra Dún training school.

The work was examined and tested while in progress by the officer in charge and the camp officers.

178. During the recess most of the fair mapping of the past season's work has been completed. It is found necessary however to retain a small drawing office at Poona during the field season; the draftsman who was in charge of this office, Ganesh Balal as before stated, succumbed to plague in September. The fair maps for the Forest department have been forwarded to the Bombay Government Photozincographic office and published, and the 2-inch sheets of North Kánara have been sent to Calcutta for reduction to 1-inch standard sheets.

179. The health of the party during the field season was not good; there was much sickness among the surveyors in the field and two were sent on sick leave. Two *khalásis* died from cholera in Thána and one peon in Poona, and three *khalásis* from pneumonia and one from plague in the Násik district.

180. The programme for 1900-1901 is in continuation of that for the past season. The survey of North Kánara will be completed in the middle of the field season and the camp employed there transferred to Belgaum to commence the detail survey in that district.

The party was inspected on the 14th and 15th of September by the Surveyor-General.*

OPERATIONS OF THE FOREST SURVEY BRANCH.

181. Mr. W. H. Reynolds, Superintendent, Survey of India Department, held administrative charge as Superintendent, Forest Surveys, Bengal Presidency, throughout the year under the orders of the Inspector-General of Forests and the professional control of the Surveyor-General. On the 30th of September 1900 Mr. Reynolds retired from the Department after a total service of nearly forty years during the last ten of which he held the appointment of Superintend-

* Mr. S. F. Norman as usual performed his duties in a most efficient manner and deserves the highest praise for his uniformly thorough supervision of his camp. Mr. Veale proved himself a capable and hard-working officer both in the field and in office. N. R. Patvardhan as a triangulator and Hari Ramchander, R. K. Gokhale, and D. R. Purohit as plane-tablers are specially mentioned.

ent of Forest Surveys. He is succeeded by Captain P. J. Gordon, I.S.C., Deputy Superintendent, Survey of India.

182. The following detailed statement shows the areas surveyed by the Forest Survey Branch up to date :—

Province.	Area in square miles. Scales. 1"	2"	4"	8"	12"	Total.	Remarks.
Bengal . . .	...	...	185	...	...	185	
N.-W. P. and Oudh .	...	205	4,488	...	3	4,696	(a) To complete standard Topographical maps.
Punjab . . .	5,144 (a)	...	1,742	...	...	6,886	
Central Provinces .	...	...	9,451	...	...	9,451	
Burma . . .	...	94	3,218	1	...	3,313	
Assam . . .	...	...	613	...	...	613	
Berar . . .	...	1,221	936	...	...	2,157	
Total .	5,144	1,520	20,633	1	3	27,301	

The above statement does not include 31,349 square miles of forest tracts which have been surveyed on various scales by No. 20 Party before its amalgamation with the Forest Survey Branch and by other Topographical parties of the Survey of India Department.

183. In addition to the detachments employed in the Punjab, Bengal and the Central Provinces, the Burma Forest Survey Party under the executive charge of Mr. T. E. M. Claudius, Extra Deputy Superintendent, Survey of India, which had been amalgamated during the previous year with the Forest Survey Branch, continued under the administrative charge of the Superintendent of Forest Surveys, Bengal Presidency.

184. Field operations during the year were carried on in eight districts of the Central Provinces, in the Chamba State and in the Hazára and Montgomery districts in the Punjab, in Singhbhum district in Bengal, and in seven districts in Burma. Minor operations consisting of the resurvey and realignment of boundaries in Dehra Dún in the North-Western Provinces and in Kheri district in Oudh were also undertaken.

The survey operations in the Chamba State, in Montgomery, and in Biláspur, Seoni, Hoshangabad, Sambalpur, Betúl, Nimár and Saugor districts were brought to a close during the year.

185. A record of the distribution of forest growth and a classification of soils was made of all areas surveyed on the 4-inch scale except in the Singhbhum district where the forest growth only has been classified. Detailed area statements of forests were prepared in 265 sheets.

186. The outturn of field work for the year was as follows :—

Party.	Triangulation (square miles).	Traversing (linear miles).	Levelling (linear miles).	Detail survey in square miles. 1"	4"	16"	Remarks.
Forest Surveys, India .	987	482	826	(a) 249	(b) 1,713	(c) 323	(a) Surveyed for topographical purposes. (b) Including 74 miles of boundary survey. (c) Boundary survey.
Forest Surveys, Burma.	1,170	1,029	...	...	708	...	
Total .	2,157	1,511	826	(a) 249	(b) 2,421	(c) 323	

The 16-inch surveys in the Central Provinces are not detail surveys in any sense of the word, being merely boundary surveys made for the accurate comparison of the boundaries of forest reserves with those of the surrounding villages which have been surveyed on that scale. The subsequent 4-inch surveys cover the same ground, and the same area therefore cannot be claimed for both surveys as has hitherto been done. These 16-inch surveys will, therefore, in future reports, be classed as boundary surveys and the outturn will be given in linear instead of in square miles.

The topographical work was checked, as usual, by running test lines through it, as well as by examination *in situ*. The test lines amounted to 265 linear miles in Bengal and the Central Provinces, and 231 miles in Burma, while the total number of plane-table fixings of the *in situ* examination is 4,955.

187. The usual statement showing the outturn for the previous season is given below. Any comparison of results, however, by mere outturn is apt to be misleading. The nature of the country and other circumstances, such as the distance of field operations from the base, must also be considered. The number of plane-table fixings in the case of detail survey and the number of stations of observation in the case of the subsidiary operations of traversing and triangulation form the best test of work done. In the dense forests of Burma sometimes 300 to 400 plane-table fixings are required to produce a square mile of accurate 4-inch detail survey, while in the more open forests of some parts of India, a fourth of that number frequently suffices. In traversing too not only the frequency of stations but also the labour entailed in clearing the lines in heavy jungle compared with what is required in more open country, affect the outturn; and the same with triangulation; in Burma for example, an area of 60 square miles to one station of observation is not uncommon, while in the Central Provinces some 10 to 12 stations would be observed at in the same area.

Outturn for 1898-99.

Party.	Triangulation (square miles).	Traversing (linear miles).	Levelling (linear miles).	Detail Survey in square miles.					Remarks.
				1″	2″	4″	8″	16″	
Forest Surveys, India	1,092	433	839	(a) 953	...	(b) 1,587	...	(c) 326	(a) Surveyed for topographical purposes.
Forest Surveys, Burma	...	128	...	...	...	377	...	...	(b) Including 33 sq. miles of boundary survey in Montgomery.
No. 20 Party	1,200	201	...	...	87	472	1	...	(c) Boundary survey.
Total	2,292	762	839	(a) 953	87	(b) 2,436	1	(c) 326	

188. The cost-rates per square mile of detail survey for the year under report and for the preceding year are as follows:—

Province.	1898-99. Detail survey.		1899-1900. Detail survey.		Remarks.
	1″	4″	1″	4″	
	₹	₹ (a)	₹	₹ (a)	
Central Provinces	...	38·8	...	39·0	(a) Rate calculated on combined 4″ and 16″ area.
Bengal, Singhbhum	...	...	...	80·6	
Punjab	7·8	41·3	12·8	52·1	Final cost-rate.
Burma, Forest Survey Branch	...	93·8	...	97·5	(b) Average cost-rate of 2″, 4″ and 8″ surveys.
Burma, 20 Party	...	141·8 (b)			

What has been said regarding outturn applies likewise to the resulting cost-rates, and such circumstances as the cost of local labour and the facilties for procuring supplies are important factors in the results for different districts and seasons. Differences in the cost-rates for the same classes of work where similar conditions exist, require examination with reference to the above considerations and the cost *per* station of observation in the case of traversing, levelling and triangulation, and *per* 100 plane-table fixings in the case of detail survey, will afford a more accurate comparison of results than a rate *per* mile irrespective of any considerations.

189. The following statements have been prepared in illustration of the above remarks. In the first statement the results of the work of No. 20 Party for 1898-99 and of the combined Burma Forest Surveys for 1899-1900 compared according to the old system are briefly as follows :—

Nature of Operations.	Outturn.				Total Cost.		Cost-rates.			
	1898-99.		1899-1900.				1898-99.		1899-1900.	
	Square miles.	Linear miles.	Square miles.	Linear miles.	1898-99.	1899-1900	*Per* sq. mile.	*Per* linear mile.	*Per* sq. mile.	*Per* linear mile.
					₹	₹	₹	₹	₹	₹
Triangulation . .	1,200	...	1,170	...	17,168	27,341	14·3	...	23·4	...
Traversing . .	...	201	...	1,029	24,217	66,448	...	120·5	...	65·2
Plane-tabling, 4-inch scale . . .	(*a*) 515	...	708	...	79,458	69,066	152·3	...	97·5	...
Total .	...	...	...	...	1,20,843	1,62,855	...	...	...	...

(*a*) 4-inch survey . . . 472 sq. miles.
2 „ „ 87 sq. miles=43 „ „ on the 4-inch scale.
Number of surveyors, 1898-99 . . . 53.
„ „ 1899-1900 . . 69.

190. These results in the case of traversing and detail survey appear *primâ facie* to be highly satisfactory, but as the sub-joined figures show they have been obtained principally by a reduction in the number of stations in the case of traversing, and in the number of fixings *per* mile and tests applied in the case of detail survey.

Nature of Operations.	Outturn.				Cost rates.			
	1898-99.		1899-1900.		1898-99.		1899-1900.	
	Stations observed.	Plane-table fixings.	Stations observed.	Plane-table fixings.	*Per* station of observation.	*Per* 100 Plane Table fixings.	*Per* station of observation.	*Per* 100 Plane-table fixings.
					₹	₹	₹	₹
Triangulation .	18	...	23	...	953·7	...	1,188·7	...
Traversing . .	9,078	...	17,999	...	2·66	...	3·69	...
Plane-tabling, 4″ .	...	1,18,530	...	78,253	...	56·1	...	83
Testing . . .	...	23,055		4,955				
Total .	...	1,41,585	...	83,208	...	...	...	...

The increase in the area topographically surveyed is due partly to an increase in the number of surveyors owing to the amalgamation of No. 20 Party with the other detachments of the Forest Survey Branch working in Burma and partly to some of the area surveyed being in the plains and therefore more easy to survey, but chiefly to the reduction in the number of fixings *per* square mile.

191. The programme for 1900-01 is as follows:—

Province.	*Locale.*	
Central Provinces	Mandla . .	With the exception of the two districts mentioned below, the survey of the forests in the Central Provinces has been completed. In the Mandla district an area of about 2,485 square miles, and in Chánda about 1,870 square miles, still remain unsurveyed and will be taken up during the coming season.
	Chánda . .	
Ajmer-Merwara .	Ajmer-Merwara .	A surveyor, as usual, will be deputed to carry out surveys under the supervision of the local Forest Department.
North-Western Provinces and Oudh.	Oudh Circle .	In the event of the permanent demarcation of the forests being complete the survey of the pillars or such portions of the boundaries as were not finally settled at the close of the past field season, will be taken in hand.
Punjab . .	Hazára . .	The detachment that has hitherto been employed on the survey of the Chamba State will now be employed on the survey of Khágan forests. Triangulation was commenced in these forests during the summer of 1900, and the detail work will be undertaken duing the summer months of 1901.
Bengal . .	Singhbhum . .	The survey of the Singhbhum forests which was commenced during the year under report will be continued. The small survey detachment employed on this work will be strengthened by the transfer of one of the detachments from the Central Provinces.
Burma .	Ruby Mines and Bhamo.	The triangulation, traverse and detail survey of the following reserves:—Kunchaung, Maingtha, Nahan, Setkala and Nampaw.
	Pyinmana . .	The traverse and detail survey of the Zahaing and Mahan reserves.
	Pegu . . .	The traverse and detail survey of the Wanetchaung, Pyinbongyi, Yetkangyi and Kyunchaung reserves and a gap to be completed in South Zamayi.
	Thayetmyo . .	Triangulation and traverse of the Mindon Yoma reserve.
	Ataran . .	Completion of traverse and detail survey of the Ye reserve.
	Tenasserim . .	Triangulation and traverse of the Kaleinaung reserve.

CENTRAL PROVINCES.

192. Six detachments were employed during the year on field operations in the Central Provinces. The surveys in Biláspur, Seoni, Sambalpur, and Saugor were in continuation of last year's work and were brought to a close during the year. Survey operations in Hoshangabad, Betúl and Nimár were in continuation of those by the Survey Department and were also completed. The survey of the forests in Mandla was commenced during the year.

Personnel.

Mr. J. Marten, Extra Asst. Superintendent, 6th grade.
„ B. R. Hughes „ „ „
„ J. H. Nichol, Sub-Asst. Superintendent, 1st grade.
„ C. Litchfield, „ „ „
Babu Bhoop Singh, Forest Surveyor.
„ Odey Singh, „ „
One hundred and seven Native Surveyors.

The detachments proceeded to the field in November and returned to recess quarters in June.

193. The following statement shows in detail the cost and outturn in the several Forest divisions :—

Forest Division.	Cost of				Total expenditure.
	Detail survey 4" and 16" scales including mapping	Triangulation.	Traversing.	Levelling.	
	₹	₹	₹	₹	₹
Saugor	7,257	...	..	949	8,206
Hoshangabad, Betúl and Nimár	9,220	2,389	2,139	...	13,748
Mandla	15,698	...	...	184	15,882
Seoni	7,038	...	439	1,204	8,741
Biláspur	16,709	147	616	...	17,472
Sambalpur	12,306	...	146	...	12,452
Total expenditure	68,222	2,536	3,400	2,337	76,501
Outturn, square miles	1,746(a)	497	184(b)	791(b)	...
Cost *per* square mile in ₹	39·0	5·1	18·4(c)	2·9(c)	...

(a) Includes 323 square miles of boundary survey.
(b) Linear miles.
(c) Cost *per* linear mile.

194. The outturn and cost for 1898-99 are given below for the purpose of comparison : the results for the present year differ but slightly from these and the differences being due merely to altered local conditions, need not be further considered. Less triangulation was found necessary but in its place more traversing was done at a lower rate than for last year :—

Forest Division.	Cost of				Total expenditure.
	Detail survey 4" and 16" scales including mapping.	Triangulation.	Traversing.	Levelling.	
	₹	₹	₹	₹	₹
Saugor	17,328	2,770	...	...	20,098
Biláspur	10,276	...	790	...	11,066
Seoni	11,838	...	497	1,246	13,581
Chhindwára	10,730	1,929	...	...	12,659
Nágpur-Wardha with Chánda.	9,360	...	...	2,832	12,192
Sambalpur	9,504	...	...	...	9,504
Total expenditure	69,036	4,699	1,287	4,078	79,100
Outturn, square miles	1,780(a)	825	53·5(b)	827(b)	
Cost rate *per* square mile in ₹	38·8	5·7	24·1(c)	4·9(c)	

(a) Includes 326 square miles of boundary survey.
(b) Linear miles.
(c) Cost *per* linear mile.

The triangulation which consisted of extensions of existing series was done by Mr. Nichol in Betúl, Nimár and Hoshangabad, and by Sub-Surveyor Fatteh Singh in Biláspur.

Supplementary traverse lines were run in Seoni, Biláspur, Sambalpur, and in Betúl, Nimár and Hoshangabad and series of lines of levelling were run in Saugor, Mandla and Seoni in order to obtain additional heights.

The work was tested by 253 miles of check lines as well as by numerous *in sitú* fixings.

195. The following statement shows the progress of mapping up to date :—

Forest Division.	Forest area as *per* Form No. 46 for 1899-1900.		Number of sheets on 4" scale.				Remarks.
			Published.				
	Surveyed on 4" scale up to 1899-1900.	Mapped and sent to press.	Previously reported.	During the year.	At press.	In progress.	
Northern Circle.							
Jubbulpore	536	536	90	...	...	...	Mapping completed.
Narsinghpur	272	272	32	...	...	...	
Saugor	788	553	45	15	4	41	
Hoshangabad	245	...	1	...	...	3	
Nimár						4	
Betúl						...	
Mandla	466(*a*)	23(*a*)	...	...	...	3	(*a*) Twenty-three square miles in connection with Bálaghát survey.
Southern Circle.							
Raipur	1,392	1,286	65	6	3	21	
Bhandára	536	536	62	...	...	...	Mapping completed.
Bálaghát	937	937(*b*)	78	3	...	...	
Biláspur	625	66	1	...	3	7	(*b*) Includes 23 square miles given in Mandla.
Sambalpur	393	...	...	...	...	17	
Nágpur-Wardha	705	692	42	36	5	1	
Seoni	866	327	12	10	8	55	
Chhindwára	705	295	25	8	3	48	
Chánda	400	130(*c*)	6	...	...	...	(*c*) Ahiri maps published.
Total	...	...	459	78	26	200	

196. The outturn and cost of work in the several districts of which the field surveys have been completed are as follows. The cost-rates cannot, however be considered as final until all mapping and publishing charges in connection with these surveys come to an end.—

Forest Division.	Outturn in sq. miles.				Total expenditure on					Average cost-rates *per* sq. mile in Rupees.			
	Plane-tabling 4" and 16" scales.	Triangulation.	Traversing.	Levelling.	Plane-tabling 4" and 16" scales.	Triangulation.	Traversing.	Levelling.	Total Expenditure.	Plane-tabling.	Triangulation.	Traversing.	Levelling.
					R	R	R	R	R				
Saugor	1,128	1,837	...	(*a*) 379	57,945	14,318	...	2,415	74,678	51·4	7·8	...	(*b*) 6·4
Nimár, Betúl and Hoshangabad.	285	475	(*a*) 107	...	9,220	2,389	2,139	...	13,748	32·4	5·0	(*b*) 20·0	...
Seoni	1,144	855	(*a*) 58	(*a*) 923	44,838	5,907	996	3,098	54,839	39·2	6·9	(*b*) 17·2	(*b*) 3·4

(*a*) Linear miles.
(*b*) *Per* linear mile.

The Superintendent inspected the detachment working in the Central Provinces between the 11th and 28th of February.

BENGAL.

SINGHBHUM.

197. Field operations were commenced early in December 1899 and were carried on in the Chaibassa, Koina and Kolhán ranges until the end of May when the detachment returned to head-quarters. The outturn was as follows:—

Personnel.

Mr. T. S. Marten, Extra Assistant Superintendent, 5th grade, and 24 Sub-Surveyors and apprentices.

Detail survey on the 4-inch scale	185 square miles.
Triangulation	150 „ „
Levelling	35 linear miles.
Testing	12 „ „

Traces showing the distribution of forest growth have been prepared of all detail surveys.

198. The total expenditure and cost-rates of the different operations are given below:—

Forest Division.	Triangulation.	Levelling.	Detail survey on 4" scale.	Total cost.
	₹	₹	₹	₹
Singhbhum	3,084	417	14,912	18,413
Total areas, sq. miles .	150	35(*a*)	585	...
Cost *per* sq. mile in rupees.	20·6	11·9(*b*)	80·6	...

(*a*) Linear miles.
(*b*) *Per* linear mile.

199. The work was considerably retarded by sickness among the surveyors and by the scarcity of drinking water which was severely felt by the men.

The detachment was inspected by the Superintendent in the beginning of February.

The work will be continued during season 1900-1, when, in order to increase the outturn, a second detachment will be sent to carry on the work.

PUNJAB.

200. The operations in the Punjab consisted of the detail survey of the Chamba State and the 4-inch boundary survey of the reserves in the Montgomery district in continuation of former seasons, also triangulation of the reserves in the Khágan range of the Hazára district which will be surveyed in detail on the 4-inch scale during 1900-1.

201. The operations in Chamba were carried on during June, July and August and consisted of 31 square miles of 4-inch detail survey in the valley of the Chandra-Bhága river, and 249 square miles on the 1-inch scale in the eastern portion of Pangi adjoining Zanskar and Kullu. This completes the survey of the Chamba State.

Personnel.

Seven Sub-Surveyors under the personal supervision of the Superintendent.

An area of some five square miles was also traversed in and near Dalhousie and Bakloh for the purpose of fixing the municipal and cantonment boundaries.

202. The boundary survey with adjoining details of the reserves in the Montgomery district included an area of 72 square miles. The field plots on the 4-inch scale have been made over to the Conservator for working-plans

purposes, and a 1-inch outline map showing the position of the reserves was prepared and sent to press.

203. The triangulation in Hazàra, covering an area of 340 square miles in the Khágan range, consisted of extensions to existing series and was carried out by Mr. Hughes and Surveyor Amjadali between July and September.

Personnel.

Mr. B. R. Hughes, Extra Assistant Superintendent, 6th grade, assisted by Surveyor Amjadali.

204. The following statement gives the areas surveyed in the Punjab, and the cost-rates. The latter figures are not given for Chamba as the expenditure includes a considerable amount which goes against the outturn for the preceding year :—

Forest Division.	Outturn in Sq. Miles.				Total Expenditure on					Average Cost-rate.			
	Triangulation.	Traversing.	Detail Survey.		Triangulation.	Traversing (Linear miles.)	Detail Survey.		Total expenditure.	Triangulation.	Traversing (Linear miles.)	Detail Survey.	
			1"	4"			1"	4"				1"	4"
					₹	₹	₹	₹	₹	₹	₹	₹	₹
Chamba . .	...	5	249	31	2,190	547	9,439	5,952	18,128	...	...	...	...
Montgomery .	...	(a) 244·02	...	72	...	2,134	...	...	2,134	...	(b) 8·8	...	...
Hazára . .	340	...	...	...	3,061	...	...	...	3,061	9·0	...	...	...

(a) Linear miles.
(b) Cost *per* linear mile.

The 4-inch detail survey of the forests in the Jubbal and Taroch Hill States will be taken up during next field season.

NORTH-WESTERN PROVINCES AND OUDH.

205. No detail surveys were undertaken in the North-Western Provinces and Oudh during the year, but 15 linear miles of the re-aligned Nepál-Kheri boundary were measured and the position of the new pillars added to the existing maps at a cost of ₹67 or ₹4·5 per linear mile.

In the School Circle the boundaries of the Jakhan and Bidhalna reserved forests were resurveyed at a cost of ₹71.

AJMER-MERWARA.

206. The detail survey on the 4-inch scale of the forest reserves in Ajmer-Merwara was continued by a surveyor lent to the Forest officer in charge. The work was carried on under the direction and supervision of the local authorities, and the expenditure was also met locally. The preparation and publication of the maps will, however, be undertaken in this office.*

BURMA FOREST SURVEYS.

No. 20 Party.

207. Mr. Claudius held charge throughout the year. The work of the party comprised :—

Personnel.

Mr. T. E. M. Claudius, Extra Deputy Superintendent, 2nd grade, in charge.
Mr. P. F. Prunty, Extra Assistant Superintendent, 5th grade.
„ A. Ewing, „ „ „ 6th „
„ W. C. G. Barckley, Sub „ „ 1st „
„ H. A. Charrier „ „ 1st „
Sixty Surveyors, Sub-Surveyors, etc.

* Mr. Reynolds before making over charge reported as follows regarding the members of the establishments: "Mr. Claudius held charge of the Burma Party throughout the year and was of much assistance to the Superintendent, while the Provincial officers in charge of the several field detachments performed their duties in a satisfactory manner. Among the native field hands Odey Singh and Bhoop Singh who held charge of detachments and Odey Ram are deserving of special mention."

TENASSERIM CIRCLE.

Ataran Division.—Triangulation, traversing and 4-inch detail survey of the Ye and Kyunchaung reserves.

Toungoo Division.—4-inch detail survey of the Pyunchaung, Gonwe and Metindien reserves.

Shwegyin Division.—4-inch detail survey of the Binbye, Mon and Pada reserves and the traversing of the last named.

Pegu Division.—4-inch survey of the Shwelaung, Kodugwe, Salu, Kamasi and Yitkangyi reserves and traversing of the last two.

West Salween Division.—4-inch survey of the Wanuchaung, Minanwe, Mewaing, Lower Methalauk, Upper Methalauk, Pachaung, Dagwin, Sinswe, Kahilu, Onkangyi, Tagelaung, Bilakatgyi, and Kyakatchaung reserves.

Traversing was also done and triangulation revised in the West Salween division.

SOUTHERN CIRCLE.

Pyinmana Division.—4-inch survey and traversing of the Sintha reserve.

Ruby Mines Division.—Triangulation, traversing and 4-inch survey of the Nahan and Nampaw reserves and triangulation and traversing of the Maingtha and Kunchaung reserves.

A record of the classification of forest growth and soils was made *pari passu* with the detail survey of forest reserves.

208. Under the orders of Government Resolution No. $\frac{48}{8.3}$ F., dated 6th March 1899, Revenue and Agricultural Department, the operations of the party now embrace the survey of the forest reserves throughout Burma and are not confined to Lower Burma only as hitherto.

209. The party left recess quarters at Dehra Dún on 8th November, and the different sections commenced field work between the 22nd November and 4th December. The field work was brought to a close in the end of May when the party returned to head-quarters at Dehra Dún. The party was divided into four sections. The head-quarters camp, as usual, being under the officer in charge of the party. Messrs. Prunty, Ewing, Barckley, Charrier and Surveyor Amjadali held charge of the several detachments which were employed on traverse and detail survey. Messrs. Prunty and Charrier were also employed on advance triangulation, and Mr. Barckley on the revision of his previous triangulation in the West Salween division.

210. The outturn for the season is as follows :—

FOREST DIVISION.	Triangulation square miles.	Traversing linear miles.	Detail survey on 4-inch scale square miles.
Ataran	500	269·6	68·6
Pegu	...	87·5	161·2
Toungoo	...	...	29·8
Shwegyin	...	25·3	46·9
West Salween . . .	380	173·3	206·0
Pyinmana	...	101·0	106·9
Ruby Mines . . .	290	372·7	88·4
TOTAL .	1,170	1029·4	707·8

The detail work which, with one exception, was checked by 231 miles of test-lines was found to be satisfactory.

211 The outturn of detail survey is larger than that of any previous season, and the cost-rate per square mile for the same consequently lower than before. The

cost-rate for the year under report and the preceding two years are given in the following statement :—

Year.	COST-RATE *per* SQUARE MILE.				
	Triangulation.	Traversing.	Detail Survey.		
			2-inch scale.	4-inch scale.	8-inch scale.
	R	R	R	R	R
1897-98	...	57·4(a)	79·4	196·4	...
1898-99	14·2	120·5	84·7	152·3	120·4
1899-1900	23·4	65·2	...	97·5	...

(a) Linear miles

212. Of the 18 sub-surveyors made over to the party on its amalgamation with the Forest Survey Branch, seven were sent to the Training School at Dehra-Dún for further training.

213. With few exceptions the reserves under survey consisting, as they did, of intricate masses of hills covered with dense jungle were difficult to survey. Taking into consideration the very large native establishment employed and the scattered and unhealthy localities operated in, the health of the party was on the whole good. One sub-surveyor and nine *khalásis*, however, died from fever and dysentery. One elephant attendant was killed by his elephant, and one *khalási* was accidentally drowned.

214. The party was inspected by the Superintendent, Forest Surveys, in the field during the month of January and again in recess at the end of July. During the recess all the computations and most of the mapping have been brought up to date. Forty 4-inch sheets will be submitted for publication before the party leaves recess quarters.

The following statement shows the progress of the 4-inch mapping :—

Forest Division.	NUMBER OF SHEETS ON 4″ SCALE.				Remarks.
	Published.		In the press.	In progress.	
	Previously reported.	During the year.			
Salween-Ataran .	26	7	7 (a)	14	(a) 2 of No. 20 Party.
Shwegyin . .	...	3 (b)	15 (b)	...	(b) of No. 20 Party.
West Salween .	...	...	11 (b)	16	
Thayetmyo . .	...	3 (b)	7 (b)	...	
Rangoon . . .	...	...	2 (c)	...	(c) one on 8″ scale.
Pegu . . .	...	4 (b)	17 (b)	...	
Toungoo . .	...	1 (b)	4 (b)	...	
Pyinmana . .	40	1	9 (d)	2	(d) 7 of No. 20 Party.
Ruby Mines .	...	...	2 (b)	9	
Total .	66	19	74	41	

In addition to the above, eight special maps on working plans are under publication.

215. The total cost of the Burma surveys for the year is R1,70,041, of which R7,186 are debitable to the printing and publishing of maps of the Tenasserim Circle, Pyinmana and Ruby Mines, the survey of which was completed last season. The balance falls under the following heads:—

	R
Triangulation	27,341
Traversing	66,448
Detail survey on the 4″ scale	69,066
TOTAL	1,62,855*

CADASTRAL SURVEYS.

NORTH-WESTERN PROVINCES AND OUDH.

NOS. 2 AND 8 PARTIES.

216. In accordance with a recommendation of the Government of India, and the Surveyor-General Nos. 2 and 8 Parties, which had been employed on traverse operations in these provinces, were under despatch No. 44 (Revenue), from the Secretary of State, dated 15th March 1900, placed under the local Government from 1st October 1899 and amalgamated with the several cadastral establishments employed on the revision of village maps and records; the whole being now styled "Provincial Surveys" instead of "Land Record Surveys," and divided into three sections, Traverse, Drawing or Cartographical, and Cadastral, the whole under the charge of Mr. G. B. Scott, the Superintendent,

Personnel.

Mr. G. B. Scott, Superintendent.
Captain W. M. Coldstream, R. E. Deputy Superintendent.

Traverse Section.

Mr. H. T. Hanby, Extra Assistant Superintendent, 1st grade.
„ J. McHatton „ „ 4th „
„ F.S. Bell „ „ 6th „
„ G. Rae, Sub-Assistant Superintendent, 1st grade.
Fifty-eight Sub-Surveyors and Computers.

Drawing Section.

Mr. J. M. Kennedy, Extra Assistant Superintendent, 6th grade.
One Writer, 1 Record-keeper, 2 Sub-Surveyors and 7 Draftsmen.

Cadastral Section.

Mr. J. F. Freeman, Deputy Collector, Survey Officer, Azamgarh
„ J. R. Newland, Sub-Assistant Superintendent, 3rd grade Assistant Survey Officer, Azamgarh.
Mr. L. F. Berkeley, Extra Assistant Superintendent, 6th grade, Survey Officer, Mainpuri.
Mr. S. F Norman (Jr.), Sub-Assistant Superintendent, 3rd grade, Assistant Survey Officer, Mainpuri.
Mr. P. C. H. Smart, Extra Assistant Superintendent, 6th grade, Survey Officer, Farrukhabad.
Mr. C. S. Littlewood, Sub-Assistant Superintendent, 3rd grade, Assistant Survey Officer, Farrukhabad.
Mr. O. D. Smart, Extra Assistant Superintendent, 6th grade, Survey Officer, Etáwah.
Mr. H. C. W. Stotesbury, Sub-Assistant Superintendent, 3rd grade, Assistant Survey Officer, Etáwah.
Mr N. Bedford, Extra Assistant Superintendent, 6th grade, Survey Officer, Gonda.
Mr. J. H. Murphy, Sub-Assistant Superintendent, 1st grade, Assistant Survey Officer, Gonda.
Mr. W Skilling, Extra Assistant Superintendent, 6th grade, Survey Officer, Pilibhit.
Mr. C. H. G. Johnson, Sub-Assistant Superintendent, 3rd grade, Survey Officer, Bisalpur.
Mr. F. B. Powell, Sub-Assistant Superintendent, 1st grade, Survey Officer, Etah.
Mr. O. C. Ollenbach, Sub-Assistant Superintendent, 1st grade, Survey Officer, Aligarh.

217. *Traverse Section.*—Traverse survey operations were continued in portions of districts Etáwah, Etah, Mainpuri, and Gonda; and commenced in district Jálaun. In addition several scattered villages in district Aligarh were traversed, and some in Kheri in connection with a transfer of villages between the Forest Department and Khairigarh Estate.

The total area traversed was 2,644 square miles, the number of village boundaries traversed in this area was 2,165, and there were 2,758 sub-traverse

* Mr. Claudius reports very favourably on Mr. Ewing who was the mainstay of the Party both in field and office, and of the native establishment that Surveyors Amjadali, Sharfuddin, H. Davis, Maung Kyaw Nyein, Maung Hpo Nyein, Jamaluddin Khan, and Mohiddin Beg, Behari Lal Roy, computer, and Muhammad Abdul Karim, writer, have given every satisfaction in the discharge of their duties.

N. W. P. & OUDH SURVEY.

INDEX TO THE CADASTRAL SURVEY IN N. W. P. & OUDH.

1899-1900.

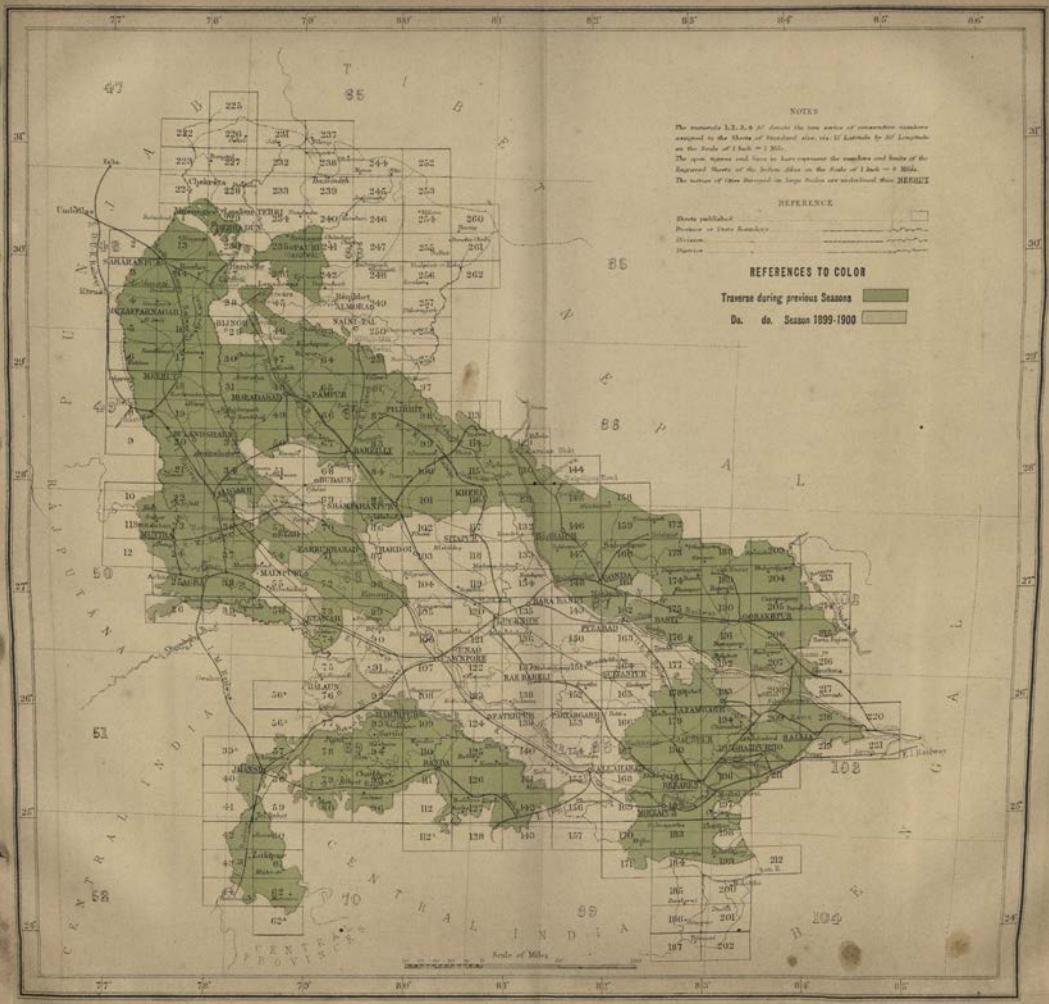
Reg. No. 651, B. L. D.—Mar. 01—[illegible]

Litho., S. I. O., Calcutta.

N. W. P. & OUDH SURVEY.

1899-1900.

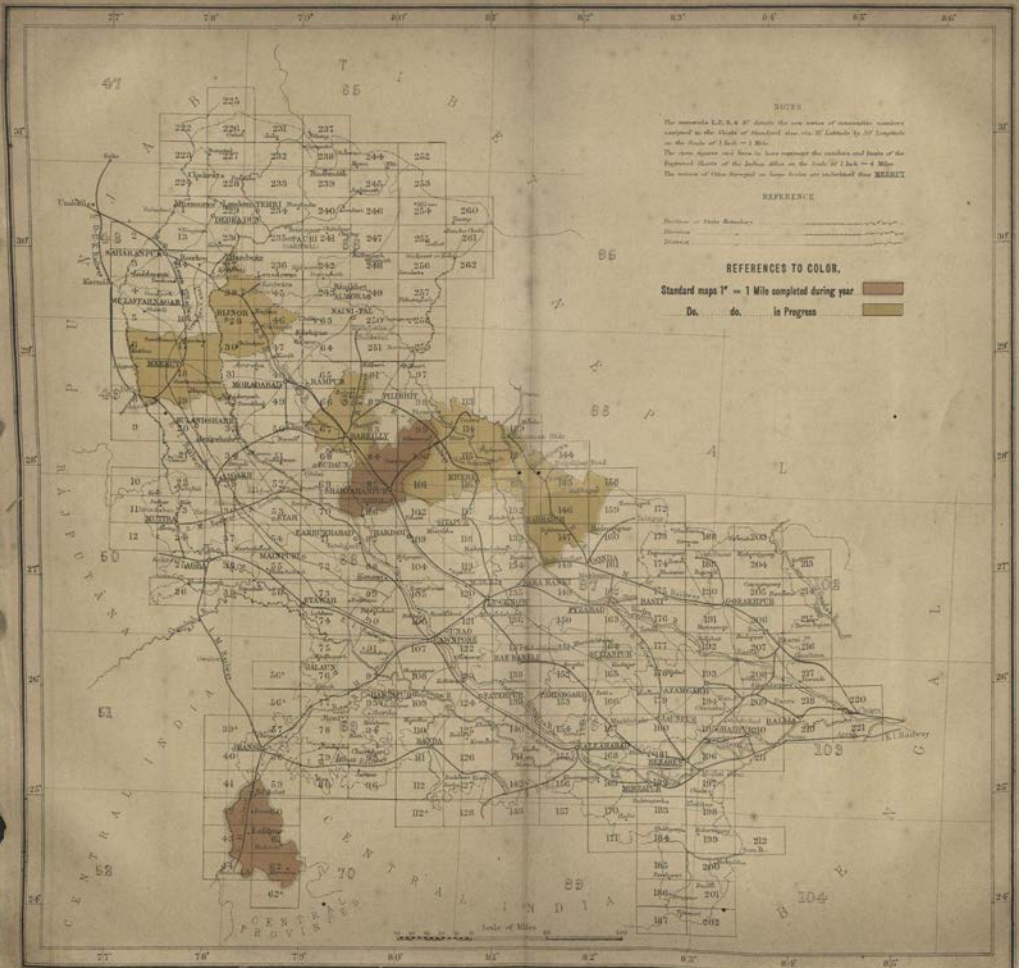
INDEX TO THE TRAVERSE SURVEY IN N. W. P. & OUDH.



N. W. P. & OUDH SURVEY.

INDEX TO THE PROGRESS MADE IN DRAWING OFFICE

1899-1900.



Reg. No. 416, S. I. D.—Feb. 01—500.

Litho., S. I. D., Calcutta.

lines run within the village circuits to facilitate the cadastral survey. The total length of chaining was 9,244 linear miles, and the total number of theodolite stations, 42,473. The angular work was checked by 283 azimuth observations, and at each of these points the magnetic variation was observed, to obtain the mean variation for each district for the year. The chaining was checked by connection with nine Great Trigonometrical Survey stations.

218. The number of survey stations fixed varied from 11 to 19 *per* square mile according to the nature of the country. Of these an average of two *per* square mile were masonry platforms or stones previously placed by local authorities to mark triple junction points of villages. Four *per* square mile were marked by stones placed by the surveyors and the remainder by baked clay cylinders enclosing a little charcoal. With reference to the marking of stations by cylinders, Mr. Freeman reports from Azamgarh that many cylinders had been destroyed and time was lost in searching for others that had been buried flush with the ground, as the small earthen mounds originally placed over them to mark the sites had been washed away. This last was inevitable, and is not a serious objection. The Survey officers working in other districts on the other hand report that most of the embedded cylinders were found uninjured and without much difficulty. The question of using more stones in place of cylinders for permanently marking survey stations has been under discussion for some time. When the traverse survey of a district is followed within a year or two by the cadastral survey, there is no necessity for increasing the number of stones as now used, especially as the state of the survey marks is now to be reported on yearly by *patwáris*. When traverse operations begin, no doubt children remove a few cylinders here and there, but with an average of six well marked stations and some eight or nine marked with cylinders in every square mile no *patwári* once trained should find any difficulty in refixing the true site of a few lost marks in his villages, especially as having made the detailed survey himself he should know the exact position of every station, especially with a correct map of his fields to guide him. Stones cost, when placed, an average of about 6 annas per stone or R 37-8 per 100. Cylinders are purchased locally at R2-8 per 100. The cost of replacing cylinders by stone would therefore needlessly increase the cost of traverse operations, except when several years are likely to elapse between the traverse and cadastral operations, in which cases it might be advisable to add, say, two or three more stones *per* square mile.

219. The boundaries in all districts where traverse operations were carried on, were carefully demarcated in the usual way by the several district authorities before work commenced. In the broken country in Etáwah and Jálaun the subtense bar was used for obtaining correct distances between the survey stations in place of the chain. Village plots have been prepared of all the areas surveyed and have been made over to the cadastral section.

220. The total expenditure in the traverse section was R69,375-14-2, giving an average cost per square mile traversed of R26-3-4, the averages for the three previous years being R26-4-0, R26-8-4, and R29-0-3 respectively. The maximum cost per square mile allowed is R30, when an area of 2,500 square miles is the limit for the year, but owing to the addition to the original programme of over 200 square miles of traverse in the Aligarh district the average cost *per* square mile has been kept well under that figure, as it costs no more to supervise a somewhat larger area, and in addition Captain Coldstream only joined on 1st February 1900, which reduced expenditure by about R5,000. Therefore if the area to be traversed during the coming year is confined to 2,500 square miles it is probable the maximum of R30 per square mile will be attained.

221. *Drawing or Cartographical Section.*—The transfer of the drawing section to the Provincial Surveys has not altered the nature of the work for which it was originally organised, namely, the preparation of topographical maps on standard scales from the revised village maps. As before, these are being prepared on a scale of two inches to one mile for reduction to the 1-inch scale for publication. The method adopted is to calculate the co-ordinate distances of all triple junctions of villages and plot them on what are known as quarter sheets, that is, sheets containing 15′ of latitude and 7½′ of longitude; four of these when reduced make one standard sheet of the Survey of India Department, on the scale of one inch to one mile.

The details of each village map are then pentagraphed down from the 16-inch to the 2-inch scale, traced separately on transfer paper, and then entered on the sheets. Cadastral 16-inch surveys intended for settlement purposes cannot well meet all requirements of topographical maps, contours showing rises and falls in undulating country, intricate details of ravines, etc., cannot be entered without interfering with the lines indicating field limits. There is some difficulty also in selecting the main lines of traffic other than government roads and entering these only on the maps, but every care is being taken to do this in consultation with the district authorities. Where large tracts of hilly or broken country, or forests intervene between cultivation, the details are specially surveyed on the 2-inch scale.

222. During the past season blue prints of the Lalitpur sub-division were received from the Calcutta office for remarks and suggestions of the district officer, and were returned for publication. The maps of the Sháhjahánpur district were completed, but the Settlement Officer revised the spelling of a large number of the names of villages which had already been printed according to lists supplied by the collectorate. This is now nearing completion and the maps will be despatched to Calcutta for publication this month.

The district maps of Bareilly, Bahraich, Kheri, and Meerut are all well advanced.

223. The total cost of the Drawing Section for the year, including one-fourth the pay and allowances of the Deputy Superintendent from 1st February 1900, was ₹15,107-14-9, as against ₹19,769-7-2 (including ₹6,322-7 for topographical surveys in the field) in 1898-99.

224. *Cadastral Section.*—During the year under report the revision of maps and records was completed in the Pilibhít district including Bísalpur *tahsil*; continued in Farrukhabad, Gonda, and Azamgarh, and commenced in Etah, Etáwah, and Mainpuri. In addition 152 villages scattered in the Aligarh district covering an area of 384 square miles were surveyed, as the maps of previous settlement survey showed serious discrepancies when compared with the traverse plots of 1883-84. Also 27 villages covering an area of 54 square miles were surveyed in the Kheri district in connection with an interchange of land between the Forest Department and the Khairigarh Estates.

225. The total area surveyed was 3,882 square miles in 4,422 villages containing 4,296,603 fields and other items. The *khasras* were written up in the field of 3,106 square miles, 4,261 villages with 3,785,320 fields, etc. The area surveyed is in excess of the record-writing because the records of several large villages of which the survey was only completed very late in the season or not completed, were not written, to allow of the entries being for the same year in each village. This is one of the drawbacks of the two years' system of survey. It has been decided that in future all maps and records of a *patwári* circle, that have been completed during the first year of survey are to be revised and corrected when necessary as soon as the field work in the remaining villages has been completed, thus ensuring that all entries required for settlement purposes shall be for one year. The above outturn does not include the survey of 180 square miles of incompleted villages.

226. The average size of fields and other items surveyed ranged from 0·28 acres in Gonda and Azamgarh to 1·24 acres in Aligarh; but if cultivated land only is taken, the average in parts of Gonda and Azamgarh was less than 0·1 of an acre. In these two districts 54 villages were surveyed on the scale of 32 inches to a mile instead of the ordinary 16-inch scale, and several blocks of small fields were shown on 64-inch scale on the margins of maps to allow of the field numbers being distinguishable.

227. The work in Aligarh was of a peculiar nature. When the Superintendent examined the previous village maps of the district he found that in all villages of which the area did not much exceed a square mile, and which were not larger than the size of an ordinary plane-table, the boundaries and fields had as a rule, been accurately surveyed, and there seemed no occasion for a resurvey, but in many large villages the survey had, as it extended, accumulated error, or the boundaries had become seriously distorted. He recommended, therefore, that the district should be retraversed and plotted, and a comparison made between the settlement maps and plots to discover the error. He also recommended a resurvey of the alluvial tracts along the Ganges and Jumna rivers. The district

had been traversed in 1883-84 for a topographical survey on the 2-inch scale, and it was decided by the Board of Revenue that before a complete retraverse was ordered it would be advisable to utilise plots made from this traverse data for checking the present village maps. Plots, on the same scale as the village maps (that is, 2 local *bigha* chains of 52½ yards to an inch, or 16·761 inches to a mile), of all the large villages were made and compared with village maps, with the result that village maps covering an area of over 400 square miles in addition to the alluvial tracts were found seriously incorrect and needed resurvey. Traverse work necessary for a small scale survey, however, is not at all sufficient as a basis for accurate surveying on the 16-inch scale. For the topographical survey a series of traverse lines were run straight across country, the triple-junctions of villages being adopted as theodolite stations, but in many cases the stations were placed not on the platforms but at short distances away from them, near enough for topographical purposes, but misleading when used for a 16-inch survey. The larger villages covered several plane-table sheets, and most of these had but 2 or 3 survey stations on them where the boundaries fell, and generally none at all on the interior sheets. Maps made on such insufficient data would not, in all probability, be much, if at all, better than the present settlement maps. The Superintendent met the Junior Member of the Board of Revenue and the Settlement Officer in Bareilly in February 1900, and on his representation it was decided to traverse all villages to be resurveyed. Previous to this, only the alluvial tracts had been traversed. Sub-Surveyor's squads were therefore drawn from other districts and the traverse survey was pushed on, but the field season being well advanced, only the maps of *tahsils* Koil, Atrauli, Khair, and Iglás, which were urgently needed by the settlement officer could be taken up. The *patwáris* being needed for settlement work in other villages of their circles, it was found necessary to employ *amins* on this work, the number being increased as plots were prepared, and the field season was thus prolonged till July, by which time an area of 384 square miles was surveyed in 152 villages, 133 of these being based on the new traverse plots. As no funds had been specially provided for this survey, the detachment under Mr. Ollenbach was attached to the Etah district survey, and a transfer made from the budget allotments of all the parties to meet the cost. It was impossible to write up the records of such large villages, many 4 to 5 square miles in area, and this will be done by *patwáris* during the ensuing field season. There still remain about 150 square miles to be traversed and surveyed, chiefly in *tahsils* Háthras and Sikandra. Mr. Ollenbach deserves great credit for the manner in which he has worked these difficult operations.

228. The total number of *patwáris* in the tracts under survey was 1,805, of whom 1,331 surveyed their own villages and 292 nominated their heirs to be trained to execute the survey. The remainder failed either to qualify as surveyors or to nominate heirs, and the survey of their villages was done by 91 *umédwár kánungos* sent for training by the district officers. About a dozen candidates only failed to qualify. In the several districts 86 *kánungos* were trained in surveying and most of them afterwards assisted in checking work, especially *khasra* entries. All *khasra*-writing was done by the *patwáris* or their heirs with the old *patwáris* in attendance. In Aligarh 59 *patwáris* were trained, but as they were needed for settlement work in villages not being resurveyed the bulk of the survey work was done by *amins* paid by contract. Fifty *amins* were also employed in the Utraula *pargana* of Gonda district, which it was necessary to complete in one year. The jungle villages in the Kheri district were also surveyed by *amins*, as there were no *patwáris* yet in the lately constituted *mauzas*. In Etah the *patwári* school teacher and most of his pupils were trained and assisted in survey. Twenty scholars from the Agricultural School, Cawnpore, were also put through a course, only one of whom failed to qualify.

229. The average daily outturn by *patwáris* ranged from 6 acres of very small fields in Azamgarh and Gonda, to 20 acres in Mainpuri; and in *khasra*-writing from 10 to 53 numbers. In Gonda R214 were paid as rewards to *patwáris* for good work, and some of the Azamgarh *patwáris* will be rewarded when their circles are completed. In the other districts their salaries ranged from R7 to R12, and they seldom work up to areas in excess of what is fairly earned by these amounts.

230. As usual, no village maps were passed till they had been checked either by the European officers personally, or by independent check lines recorded

in field books, and tested by the Survey officer, when plotted. European officers ran 789 linear miles of check lines, 6,170 linear miles were recorded in field books, and 11,044 were run by Inspectors while work was in progress. The average of check is therefore about 4 linear miles to every square mile of survey. In Azamgarh the average was nearly 8 miles. About 12,000 acres of survey were rejected and resurveyed. Of the entries in *khasra* from 13 to 24 per cent. were checked before submission to office.

231. There were boundary disputes reported; most of them, however, being merely disagreements caused by errors in previous settlement maps, were decided amicably on the ground. Those not so adjusted, were reported to Record officers for disposal.

Work is of course much retarded, and the cost of the operations increased by the absence of *patwâris* for unavoidable causes, such as reports on crops, canals, the coming census operations, etc., also by their frequent absences without leave. Thus in Azamgarh every *patwâri* was absent on an average 51 days; in Gonda 42 days; in Mainpuri and Etah 70 days; and in Etáwah 90 days; so we lose the *patwâris'* services for from two to three months in the year, which causes delays in the preparation of papers, or necessitates the employment of *moharrirs*. The non-attendance of *zamindârs* and tenants during *khasra*-writing also causes considerable delay, especially where, as in Azamgarh, there are numerous partitions, so minute, that it is impossible to mark them on the ground, and where previous *khéwats* and other records are grossly incorrect.

232. In Azamgarh the maps and records of *tahsils* Deogaon, Nizámabad, and Atraulia are now ready for the Settlement Officer, and the survey of the Sagri *tahsil* will be commenced. In Gonda the records of *pargana* Utraula, in addition to those of *tahsils* previously surveyed, have been made over to the Settlement Officer. The whole of the maps and records of Pilibhít have been completed. In Farrukhabad the records of Chhibramau have been completed this season, and those of Kanauj well advanced. The survey of this district and of Gonda will, it is expected, be completed during the ensuing year.

233. The total expenditure under all headings in the several districts was ₹2,61,902-11-5, giving an average cost of ₹67-5 per square mile, varying from ₹50 per square mile in Azamgarh, where the cost is spread over a large area, to ₹70 in Mainpuri, where the survey of several villages has been only partially completed. To this must be added an expenditure of ₹50,092 on the head-quarter establishment, which includes cost of tents, instruments, stationery and forms, etc., in addition to the salary of the Superintendent and his establishment.

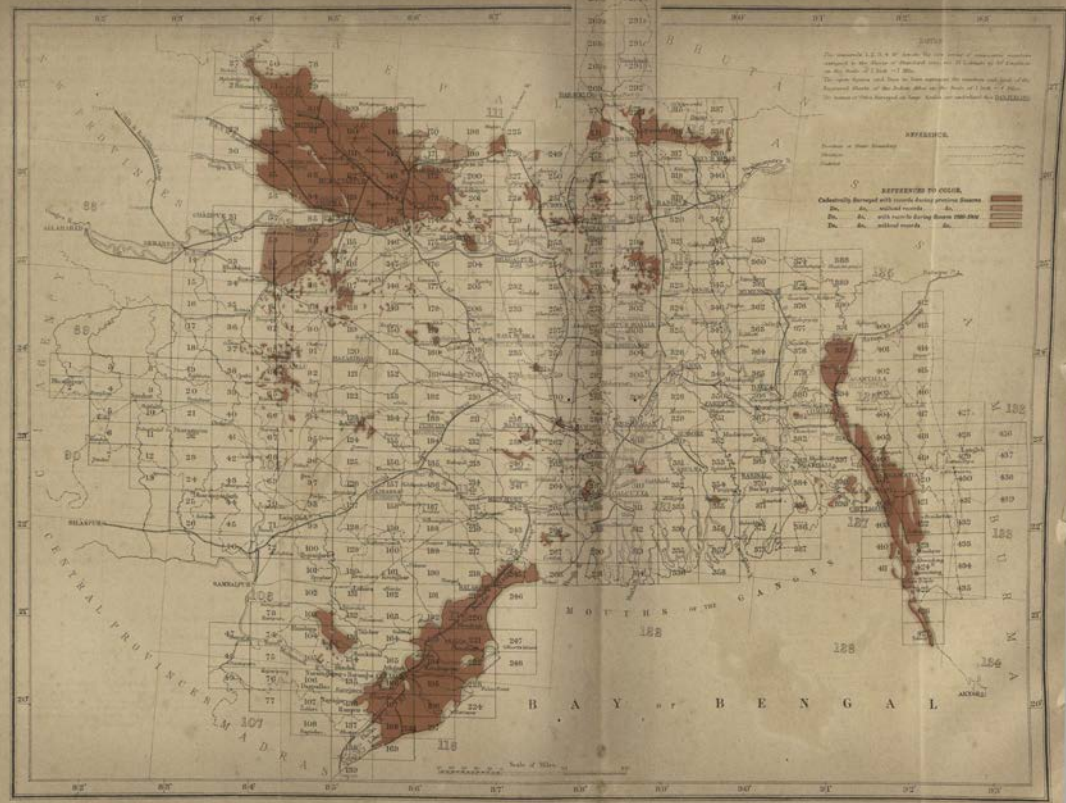
234. The orders issued shortly after the commencement of the revision surveys with reference to the mapping of Government roads and buildings, and their comparison with the maps of the Public Works Department brought to light many discrepancies between the maps of that department and the old village maps and records. Encroachments were numerous, and in many instances of too long standing to allow of rectification now, especially when, as was often the case, no proper demarcation had either been made originally, or maintained. Arrangements have now been made for a theodolite traverse of all Government roads in districts under survey and a correct record to be kept of all demarcations, and also of all Government buildings, and the boundaries of their estates on the village plans.

235. *Superintendence.*—The Superintendent visited all the districts under survey during November and December. In January he personally attended to the training of a class of 12 junior civilians, who after the preliminary course assisted materially for a month in checking the work and reporting on the capabilities of the *patwâris* in portions of Farrukhabad, Etah, Etáwah, and Mainpuri. After closing the class, the Superintendent made a tour through Mainpuri, Etah, and Aligarh, inspecting the *patwâris* in the field. He then, at the request of the Collector of Bulandshahr, redemarcated a lost boundary on the Ganges where there was a considerable dispute between the contiguous villages of Bulandshahr and Budaun. He then continued his tour through the Moradabad district, examining the village maps. This district had been cadastrally surveyed by the Survey of India Department previous to the last settlement, and the *patwâris* were provided with printed maps. These showed few changes in

BENGAL SURVEY.

INDEX TO THE CADASTRAL SURVEYS IN BENGAL.

1905-1906.



fields except in fluctuating cultivation in large *bhur* tracts and where the Ganges on the west, and the Kosi on the east of the district, had altered their courses considerably. He next replaced a lost pillar on the Nepál-Almora boundary on the Sárda river; and during April and May again visited all the districts under survey before close of field season. All the officers were again visited by him in July and August.

236. Captain Coldstream joined the Provincial Surveys on 1st February 1900, and till close of field season examined the system of work in progress in Farrukhabad, Mainpuri and Aligarh. He held charge of the traverse and drawing sections during the recess season. In July he visited the offices in Gonda, Azamgarh, Etáwah and Aligarh, to obtain a knowledge of the office procedure in record-writing.

The stoppage of survey work in Etáwah has allowed of one assistant reverting to the Survey of India Department, and the local Government have sanctioned the transfer of Mr. Newland. Mr. Norman has been transferred to the traverse section in place of Mr. Rae, and if it can be arranged Mr. Stotesbury will be employed on traverse work in Jálaun.

The Deputy Surveyor-General visited Etáwah in December to witness the training of *patwáris* under Mr. Smart. He also inspected the recess and drawing offices at Naini Tal in August, and conferred with the Board of Revenue regarding future survey operations in the province.*

BENGAL.

No. 4 Party.

237. Cadastral surveys in Bengal were continued by a staff specially deputed for the purpose and placed under the orders of the local Government. Captain Symonds as Superintendent, Settlement Surveys, Bengal, was in charge up to the 9th March 1900 when he proceeded on furlough handing over charge temporarily to Captain Mears, until Major Hodgson, returning from furlough on the 7th April 1900, took over charge which he continued to hold for the rest of the season.

Personnel.

Captain C. W. H. Symonds, I.S.C., Officiating Deputy Superintendent, 1st grade, in charge to 9th March 1900.

Captain A. Mears, I.S.C., Assistant Superintendent, 1st grade, in charge from 10th March to 6th April 1900.

Major G. B. Hodgson, I.S.C., Superintendent, 2nd grade, in charge from 7th April 1900.

238. The following shows the various estates in which operations were carried on during the season and the outturn in square miles in each: —

Division.	District and Estate.	Traverse Survey.	Cadastral Survey.	Record writing.
Private Estates.		Sq. ms.	Sq. ms.	Sq. ms.
Major Settlements.				
Bhágalpur . .	Monghyr	542	...	...
Patna . . .	Darbhanga	...	917	731
Miscellaneous.				
Patna . . .	Darbhanga municipality . .	...	...	4
Benares . . .	Ballia (*Mauza* Jauhi) . . .	8	7	7
		550	924	742

* The Superintendent reports that Captain Coldstream has been of great assistance while in charge of the traverse and drawing sections, and has devoted much spare time to gaining an insight into the several details of record work. He also reports that all the officers in the cadastral and traverse sections have worked with their usual zeal and ability, while Mr. Kennedy in charge of the drawing section deserves great credit for his methodical work, and careful attention to every detail.

In addition to the above a large area in *thánas* Banipati and Khajauli of Darbhanga was retraversed, because many of the stations of the traverse survey which had been done in 1893-94 could not be found.

239. The various recess offices closed towards the end of October 1899, and field work commenced about the 1st November and continued till between the middle and end of April 1900, when the various sections of the party returned to their respective recess quarters at Mussoree, Bhágalpur and Dumka.

240. No alterations were made in the general procedure of the preceding season. There was again a marked improvement in the attendance of *raiyats* due to the use of the new non-attendance forms introduced last season and the new system of dealing with attestation *badars* of the previous season's work, which was also introduced last season, was found to work admirably and thoroughly justified the change. This season it was decided to deal similarly with what are called "case" *badars* which arise out of applications under Section 103 of the Bengal Tenancy Act.

241. To get correct spelling of the village names for the 16-inch cadastral maps and standard sheets it was arranged that as soon as possible after the close of attestation proceedings, complete lists giving the correct village names in English and Hindi should be sent to the cadastral camps by the Settlement Officer. In the camp offices, the village names in English as given in these lists will be entered on the original field sheets and the spelling of the Hindi names will be checked. These sheets will then be forwarded to the Drawing Office in Calcutta together with the Settlement Officer's lists with which a final comparison will be made of the names as entered on the standard sheets.

242. Seventeen covenanted officers of the Civil Service were attached to this party during the field season and given a course of instruction in survey and record-writing.

MONGHYR DISTRICT.

243. The traverse survey of this district was commenced this season with an outturn of 542 square miles containing 1,059 villages. The origin of survey is the intersection of the meridian of 86°-30′ E. longitude and the parallel of 25°-30′ N. latitude. The area traversed is divided into three main and 33 sub-circuits and the number of linear miles of new chaining is 2,223. The angular work was checked by 93 observations for azimuth at an average of one to every 24 miles of chaining. The number of new stations is 12,250 of which 1,354 were marked with stone prisms, 10,499 by clay cylinders and 397 by wooden pegs. Five Great Trigonometrical Survey stations fell into the area traversed, but one had been washed away by the Buri Gandak river, so that only 4 were connected and gave an error in the chaining of 11·4, 4·8 and 4·8 feet between the respective stations.

Personnel.

Mr. H. Dowman, Extra Assistant Superintendent, 1st grade, in charge to 30th April 1900 and from 17th June to end of season.

Captain A. Mears, I.S.C., Assistant Superintendent, 1st grade, in charge from 1st May to 16th June 1900.

23 Sub-Surveyors and 16 Computers and Draftsmen.

244. The cost-rate of the traverse survey in the Monghyr district for the season is ₹54·7 including stone embedding. This high rate is due to the small area which was all that was required in North Bihar to provide work for 2 cadastral camps the ensuing season.

The health of the establishment was good throughout the season. The demarcation was good and every assistance was willingly given to the survey. The 16-inch plots were all forwarded to the cadastral camps and all computations completed before the end of the season.

DARBHANGA DISTRICT.

245. The *traverse survey* of this district was completed last season, but part of the area which came under cadastral survey this season was traversed in 1893-4, and many of the small clay cylinders marking the traverse stations could not be found and had to be relaid while cadastral survey was in progress.

246. *Cadastral Survey.*—The original programme provided for the completion of the district, 941 square miles, but the Settlement Department were not able to arrange for the supervision of the record writing of the whole area, so the programme was reduced, which accounts for the small outturn, especially in *khánápuri*. The area surveyed cadastrally on the 16-inch scale is 917 square miles in *thánas* Banipati, Khajauli and Phulparas. It contains 727 villages and 1,498,210 fields. The records were written in only 599 villages with 1,228,595 fields and an area of 731 square miles. The survey was mapped on 1,293 sheets on the 16-inch scale, the village sites being surveyed on the 64-inch scale on 952 additional sheets.

Personnel.

Section I.

Mr. A. W. Smart, Extra Assistant Superintendent, 5th grade, in charge.
„ C. S. Gasper, Sub-Assistant Superintendent, 1st grade.
„ H. H. S. Hanby, „ „ 2nd grade.
„ P. L. Causley, „ „ „
3 Head Inspectors.
20 Inspectors.
227 Amins.
203 Muharrirs.
27 Computers, draftsmen, etc.

Section II.

Mr. C. S. Kraal, Extra Assistant Superintendent, 6th grade, in charge.
Babu Nilmoni Chatterjee, Sub-Assistant Superintendent, 1st grade.
Mr. E. G. Hardinge, „ „ 2nd grade.
Mr. A. E. LeFranc, Supervisor.
3 Head Inspectors.
26 Inspectors.
260 Amins and 119 others.

247. The total of the check lines run by Assistants and independently comes to 2,499 linear miles and by Inspectors 2,674 linear miles, an average of 4·5 linear miles per square mile of survey. The accuracy of the village sites was tested both by independent surveys and test lines.

The number of *khasra* entries checked by the superior survey staff is 16,797 and by inspectors 341,847 which gives an incidence of 29 per cent. The average size of the field in the area surveyed is 0·37 acre.

248. The present survey on the 16-inch scale of the Nepál boundary, as much of it as fell into the season's operations, was carefully compared with Colonel Tanner's survey of the boundary of 1882-3 and a trace and full report were furnished to the Collector.

249. During the recess all maps and records were completed. The former with the field area statements were retained in the camp offices for the disposal of attestation *badars* and the latter with traces have been handed over to the Settlement department.

Attestation *badars* of the previous season were dealt with in 1,147 villages out of a total of 1,982, the percentage of plots affected being 0·46.

250. The cost-rates for the season are R72·3 per square mile for survey, R69·5 for record writing and R70·8 for area extraction, preparation of traces and completion of records. These rates are high but this is due (as stated above) to the small outturn.

MISCELLANEOUS SURVEYS.

251. The record of occupancy of the Darbhanga Municipality was written this season. The number of holdings is 30,326, averaging ·07 of an acre. The entries against 4,971 plots were checked by the supervising staff. Traces of the whole of the survey, which is on the 64-inch scale, have been furnished to the Municipal committee as well as all the records. The wall map on the 16-inch scale will follow shortly.

252. A traverse and cadastral survey with record of rights of Jauhi *mauza* in the Ballia district of the North-Western Provinces and Oudh was carried out this season at the request of the Dumráon Ráj. The area of the village is 4,336 acres and it contains 3,084 fields. The mapping was done on the 16-inch scale on 9 sheets, the 64-inch scale being employed for the village site which was surveyed on 2 separate sheets.

253. The records and traces of the 64-inch survey of the urban area of the Chapra Municipality were completed this season and made over to the Municipal committee. The tracing of the 16-inch wall map was almost completed.

254. The following is the programme of cadastral surveys in Bengal for 1900-01 :—

(*a*) Cadastral survey with record of rights of 563 square miles in the Darbhanga district, which will complete the survey of the district.

(*b*) Cadastral survey with record of rights of 750 square miles in the Monghyr district.

(*c*) The traverse survey of 600 square miles in the Monghyr district and of 750 square miles in the Purnea district for cadastral survey by this department the following season.

(*d*) The traverse and topographical survey of 90 square miles of hilly ground in the northern portion of the Champáran district to complete the survey of that district, the area not having come under cadastral survey.

(*e*) The traverse survey of 600 square miles in the Backergunge district for cadastral survey by this department the following season.*

UPPER AND LOWER BURMA.

No. 7 PARTY.

255. With the exception of the three months during which Mr. Gilbert-Cooper directed operations, Mr. Little was in charge of this party throughout the year.

Personnel.

Mr. B. G. Gilbert-Cooper, Deputy Superintendent, 1st grade, in charge from 21st December 1899 to 21st March 1900.
Mr. E. G. Little, Extra Deputy Superintendent, 2nd grade, in charge up to 20th December 1899, and again from 22nd March 1900.
Mr. J. Connor, Extra Assistant Superintendent, 2nd grade.
„ G. W. Jarbo, „ „ 3rd grade.
„ G. C. Swiney, „ „ 4th grade, till 8th October 1899.
Mr. J. S. Swiney, „ „ 4th grade.
„ C. W. Wilson, „ „ 5th grade.
Babu Abinash Chunder Bose, Sub-Assistant Superintendent, 2nd grade, from 9th October 1899.
Babu Jagdamba Pershad, Sub-Assistant Superintendent, 2nd grade, from 23rd January 1900.

The camps in Upper Burma started for the field on the 13th November, and the one for Lower Burma towards the end of that month, returning to recess quarters in detachments between the end of May and 13th of July, on completion of the work apportioned to each camp. The head-quarters and Lower Chindwin cadastral camp was in charge of Mr. Little, and the Lower Chindwin traverse camp in charge of Mr. Jarbo ; Mr. Connor, as usual, supervised the working of the drawing and arrears camp at Mandalay, while Mr. J. S. Swiney had charge of the operations in Lower Burma, and Mr. Wilson of those in Katha. Mr. J. S. Swiney also conducted the survey of the Mandalay cantonments and bazaars during the recess months.

256. The programme for the year in Upper Burma was to traverse 790 square miles, and cadastrally survey 762 square miles in the Lower Chindwin district; also resurvey five villages in the Katha district. In Lower Burma it consisted of a cadastral resurvey of 152 square miles of Bawni circle in the Pegu district (rendered necessary owing to the extensive alterations that had taken place) and a large scale survey on 64 inches to the mile of the town and civil station of Toungoo. Later on, the survey of the Mandalay cantonments on the scale of 16 inches to the mile and the cantonment bazaars on the scale of 132 inches to the mile was added and carried out during the recess months, at the request of the Burma Government.

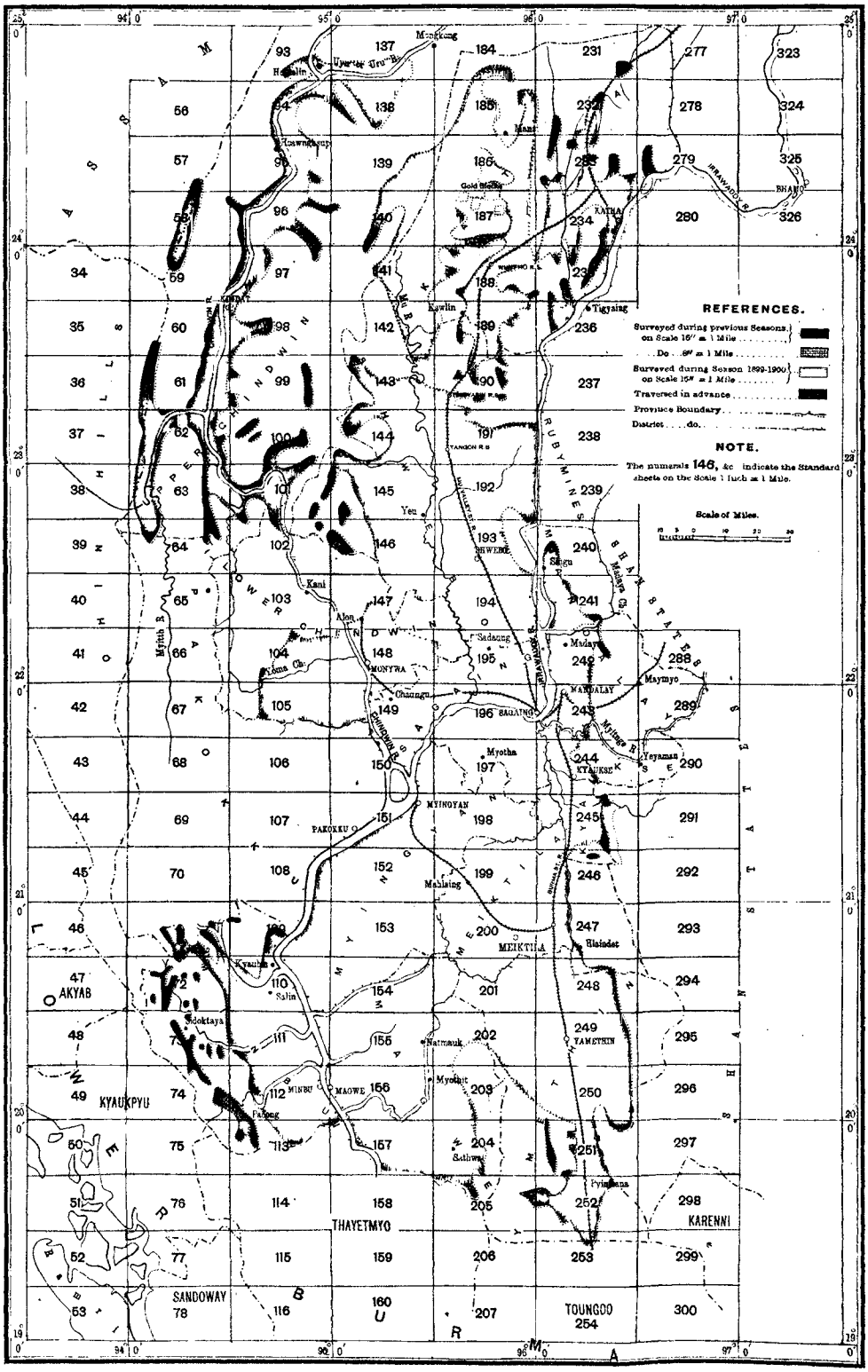
257. The areas actually accomplished are slightly in excess of those down in the programme, especially in the portion cadastrally surveyed in the Lower Chindwin district; this was done with the object of completing all the work on the left bank of the Chindwin river, and thus obviating the inconvenience of having to work on both banks the following year; and in Bawni circle the area of Pado Karen Reserve was not included when the programme was made out, as it was thought it would not need resurvey.

* The Superintendent reports well of all his assistants, and specially mentions many of the native establishments.

BURMA SURVEY.

INDEX TO THE CADASTRAL SURVEY IN UPPER BURMA.

1899-1900. No. 7 PARTY.



Reg. No. 311, S. I. D.—Jan. '1.—600.

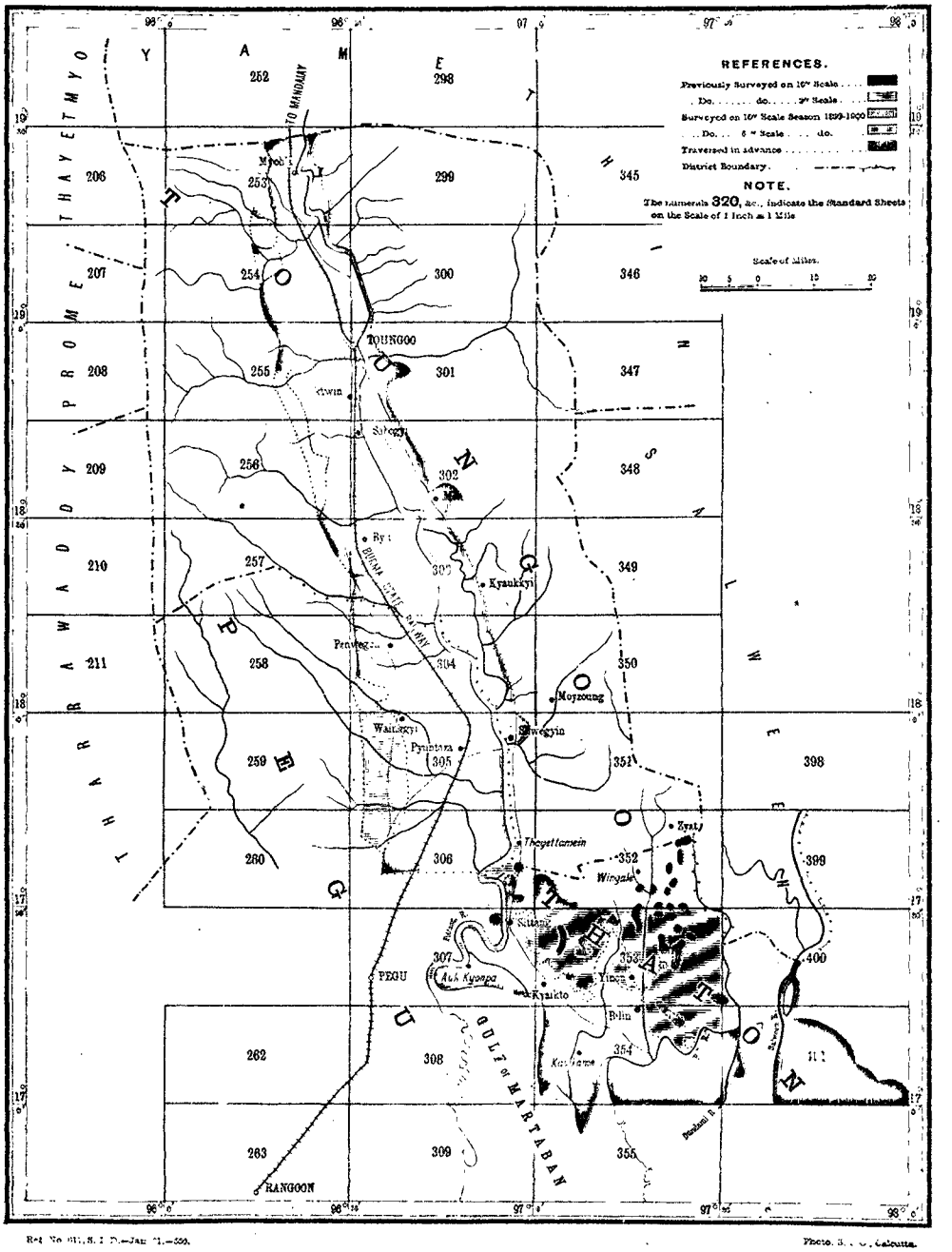
Photo S. O., Calcutta.

No. 311-S. 01.

BURMA SURVEY.

INDEX TO THE CADASTRAL SURVEY IN DISTS. THATON, PEGU, & TOUNGOO.

1899-1900. No. 7 PARTY.



Reg. No. 611, S. I. D.—Jan. 01.—550.

Photo. S. . . . Calcutta.

No. 310-S. 01.

258. The following statement gives particulars of the work done and the cost *per* square mile:—

District.	Traversing.			Cadastral Survey.				Scale.
	Villages.	Square miles.	Cost per square mile.	Villages.	Square miles.	Fields.	Cost per square mile.	
			R a. p.				R a. p.	Inches to the mile.
Lower Chindwin .	495	815·53	59 1 0	437	829	369,475	99 15 10	16
Katha resurvey .	...	...	...	8	15	8,717	633 10 8	16
Mandalay cantonment and bazaars .	3	5·2	...	3	5·2	4,293	479 0 0	16 & 132
Pegu (Bawni circle) .	...	...	...	93	183·1	127,921	234 2 6	16
Toungoo town and civil lines . .	1	2·2	...	1	2·2	4,086	1,572 7 0	64
Total .	499	822·57	...	542	1,034·5	514,492	...	

The cost of the survey, both traverse and cadastral, in the Lower Chindwin district, where the bulk of the area lay, compares favorably with that of work in the same and other districts during previous years; the traversing having cost R81·5 per square mile and the detail survey R121·5 in the Lower Chindwin district, and R135·9 in Toungoo during 1897-98. The town and civil station of Toungoo, the cantonments in Mandalay and the resurvey of eight villages of Katha, were exceptional pieces of work, and their cost-rate is, in consequence, abnormally high, since the areas are small.

259. Connections to five stations of the Trigonometrical Survey were made, and 118 azimuths were observed in the Lower Chindwin district, and 4 in the Mandalay cantonments. The chains were tested weekly by the standard laid down in camps, and the sub-surveyors were inspected frequently in the field by the camp officers to ensure accurate work. In Pegu the detail survey was based on the old traverse survey of 1895-96; about 80 per cent. of the clay cylinders laid down to mark theodolite stations were found in a good state of preservation; 10 per cent. were broken and the remaining 10 per cent. could not be traced at all. Portions of the country brought under traverse survey in the Lower Chindwin district had been demarcated some years previously, but the size of some of the *kwins* being found too large, they were sub-divided into smaller *kwins* after they had been surveyed, consequently a good deal of time was lost both in the field and in office, as the sub-surveyors had to go over the ground a second time, and retraverse the sub-divided *kwins*.

260. The cadastral work in the Lower Chindwin and Katha districts was mapped on 1,011 sheets on the 16-inch scale, to check which 2,363 linear miles, or an average of 2·80 linear miles per square mile, of test lines were chained by assistants, independent *partallers* and inspectors. In most cases the work was found to be very good, though portions of many of the sheets, those surveyed by Burmans especially, had to be revised, and in some cases, resurveyed altogether, but at the expense of the men who made the original survey. The average size of fields in Lower Chindwin works out to 1·44 acres, and in Katha to 1·11, including jungle. In Bawni circle of the Pegu district there were 266 sheets on the 16-inch scale; the town and civil station of Toungoo were mapped on 34 sheets on scale 64 inches to the mile, and the Mandalay cantonments and bazaars on 48 sheets, 8 of which were on 16 inches to the mile, and the remaining 40 on the scale of 132 inches to the mile. To test the accuracy of the work, 509·3 linear miles of *partál* were chained in the Bawni circle, 11·7 in the town of Toungoo and 19 in the Mandalay cantonments and bazaars. The

average size of fields in Lower Burma is 0·42, and in Mandalay cantonments 0·33 of an acre.

The season's work has been completed, and the traces of the 16-inch sheets and their area statements submitted to the local authorities.

261. The arrears camp and drawing office managed by Mr. Connor has, as usual, been engaged in preparing and completing 2-inch sheets, making traces of the same and of maps on other scales for the Settlement and Irrigation Departments, making second and third sets of tracings of the 16-inch maps for the Land Records Department, revising boundaries on traces and original sheets in accordance with Settlement Officer's directions, recasting field area statements to suit the alterations made, finishing up and binding volumes of field books, traverse tables and field area statements, and seeing generally to the completion of the vast amount of records that have to be dealt with. There will be work for this camp till the settlement operations in the province are concluded, and the last changes in boundaries made, or the maps will not be up to date. The following statements show the progress that has been made:—

MAPPING OF STANDARD SHEETS—2-INCH REDUCTIONS.

DISTRICTS.	Sheets submitted for publication previous to 30th September 1899.	Sheets submitted for publication during 1899-1900.	Sheets remaining in hand.	REMARKS.
Meiktila	24	...	...	
Shwebo and Yeu	...	65	...	
Upper Chindwin	...	...	63	
Katha	...	...	53	
Yamèthin	36	...	...	
Myingyan	...	15	23	
Minbu	...	17	...	
Lower Chindwin	...	...	(a)20	(a) Number of sheets in district Lower Chindwin not final, as the survey of the district has not been completed yet.
Magwe	...	20	27	
TOTAL	60	(b)117	(a)186	(b) Excludes 9 sheets of Yamèthin retyped owing to wrong spelling of names.

CADASTRAL SURVEY MAPPING—SCALE 16 INCHES = 1 MILE.

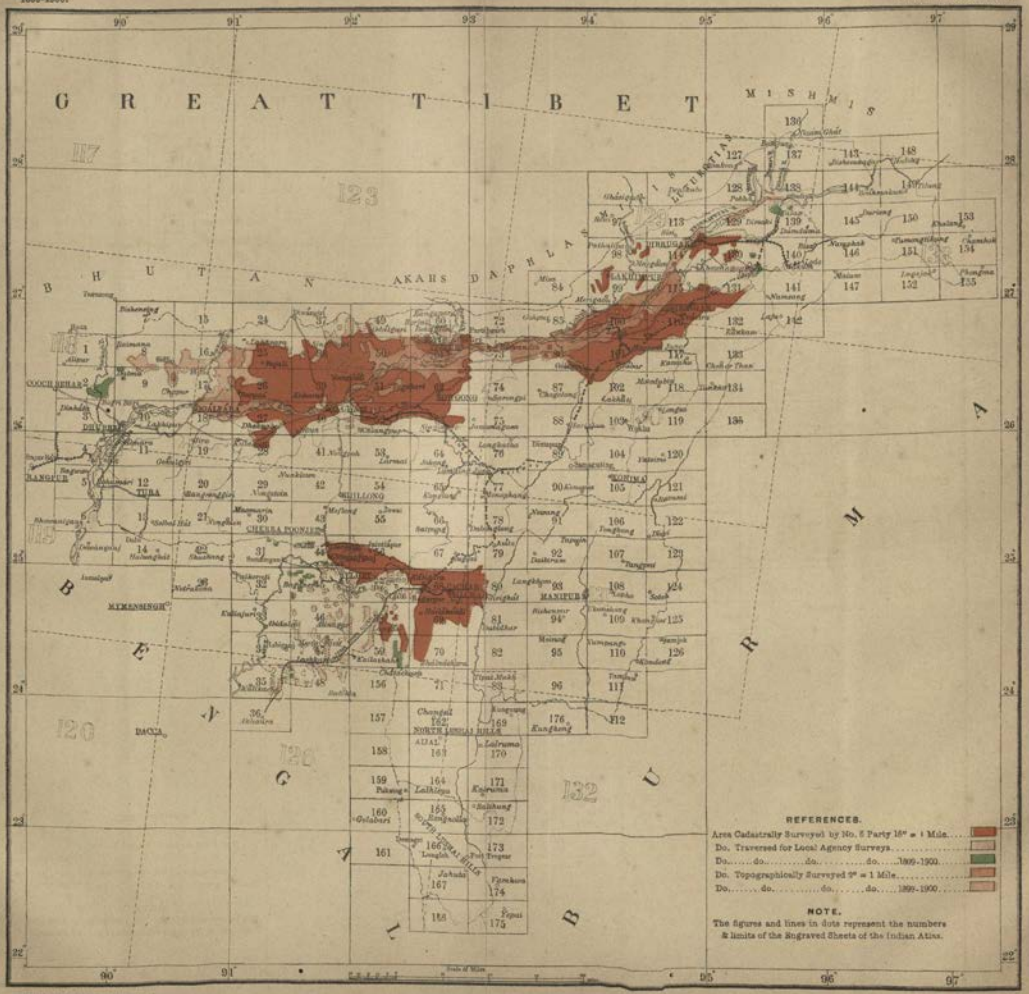
DISTRICTS.	Sheets submitted for publication previous to 30th September 1899	Sheets submitted for publication during 1899-1900.	Sheets remaining in hand awaiting settlement operations.	REMARKS.
Meiktila	1,846	...	...	
Shwebo and Yeu	2,796	765	...	
Upper Chindwin	...	...	792	
Katha	1,605	30	...	
Yamèthin	...	300	2,107	
Myingyan	...	...	3,987	
Minbu	...	351	33	
Lower Chindwin	...	...	1,493	
Magwe	...	2,556	...	
TOTAL	6,247	4,002	8,412(c)	(c) These figures are liable to alteration until settlement operations have been completed.

In addition to the above, 20 sheets on the scale of 2 inches=1 mile, and 1,443 cadastral maps on the 16-inch scale of district Toungoo, surveyed in 1897—99, were submitted for publication, making a total of 137 2-inch and

ASSAM SURVEY.

INDEX TO RECENT CADASTRAL, TRAVERSE, & TOPOGL. SURVEYS IN THE BRAHMAPUTRA & SURMA VALLEYS.

1899-1900. ASSAM DETACHMENT.



Reg. No. S.T. & I. D.—Feb. 01.—250.

Photo. S. I. O. Calcutta.

No. 312-S. 01.

5,445 16-inch cadastral sheets submitted, exclusive of 4,252 16-inch sheets sent to be lodged in the head-quarters office.

The original 16-inch plans of 218 villages on 346 sections of district Yaméthin have been sent to the Settlement Officer, at his request, for resurvey, as many alterations were needed and some omissions found in them.

262. In accordance with the rules laid down by the Commissioner of the Division, the coolies employed in the Lower Chindwin district, were paid at the rate of six annas per diem, being 50 per cent. above the rates that have generally prevailed hitherto in other parts of the province, and more than is paid for the *khalásis* imported from India. This has caused greater expenditure for coolies than was anticipated, and the amount allotted for the purpose in the budget has proved insufficient in consequence; arrangements have been made to employ *khalásis* only in future.

263. The country operated in was of the usual description—very jungly along the limits of fields, rendering the cutting of lines an absolute necessity, even when cultivation was being surveyed. A peculiar feature in the country surveyed in the Lower Chindwin district is the number of extinct volcanoes met with. In the villages of Twin and Nattobo, amongst others, on either side of the Chindwin river, and about two miles from it, are the two principal ones called "cup" and "saucer" by the Burmans. Lakes over 100 feet in depth and about half a mile across, have formed at the bottom of the craters, containing water of a disagreeable colour and odour, and tasting strongly of sulphate of soda. The level of the lakes is below that of the water in the Chindwin river, and, strange to say, the water seems to rise when the river is at its lowest and fall when it is at its highest.

264. At the beginning of the field season the native establishment in Upper Burma was attacked with cholera, and one sub-surveyor and six menials succumbed to the disease within a week, in spite of all that could be done for them; fortunately the visitation was not of long duration. One *amin* and two *khalásis* also died from fever, and one *amin* was drowned. In Lower Burma fever was more prevalent, and lasted throughout the season, but it was not of a very virulent type.

The party was inspected by the Officiating Deputy Surveyor-General on 29th and 30th March at Mandalay.*

TRAVERSE SURVEYS.

ASSAM.

ASSAM DETACHMENT.

265. On the abolition of No. 6 Party (Assam) this detachment was constituted on the 1st November 1899 under the orders of Government accompanying Revenue and Agriculture endorsement No. 1703-4-7, dated 25th July 1899. Mr. O'Donel, who was on deputation with the Assam Government as Superintendent of Land Records, reverted to the active list of the Survey of India Department and was placed in charge with the designation of Superintendent, Provincial Surveys. He continued in charge till his retirement on superannuation pension on the 9th of July, when he was succeeded by Mr. Shaw. The sub-surveyors, instruments, etc., were transferred from No. 6 Party.

Personnel.

Mr. J. H. O'Donel, Extra Assistant Superintendent, 2nd grade, in charge up to 9th July 1900.
Mr. T. Shaw, Extra Assistant Superintendent, 4th grade, from 20th May 1900, in charge from 10th July 1900.
Mr. C. A. O'Donel, Sub-Assistant Superintendent, 2nd grade, from 1st November 1899.
8 Sub-Surveyors.
6 Computers and Draftsmen.
1 Writer.

266. The programme of work to be undertaken was very scattered, extending

* Mr. Little reports that Messrs. Connor, Jarbo, Swiney and Wilson and Babus A. C. Bose and Jagdamba Pershad have all given satisfaction, and that the following are deserving of mention amongst the native establishment:—Soshi Bhusun Ghosal, Durga Prosonno Shome, C. Abrew, Gaya Pershad, Shadi Lal, Mohtab Khan, Abdul Aziz Khan, Tawakal Hosain, Sheikh Abdulla, Vardrajulu, and the Writer, Bhugobutty Charan Chakarbutty.

rom the boundary of Hill Tippera in south Sylhet to Saikhoa near Sadiya in district Lakhimpur. It consisted of traversing as follows :—

	Sq. miles.
Sylhet district—	
(i). *Ilám* lands	24·54
(ii). *Khás* lands	4·31
(iii). Tea grants	2·26
(iv). Disforested area	66·00
Goálpára district—	
(v). Duár Guma	70·00
Lakhimpur district—	
(vi). *Mauzas* Jaipur and Saikhna	60·00
(vii). Brahmaputra river	200·00
TOTAL	427·11

In addition to the above, it was proposed to undertake the topographical survey on the scale of 2 inches to the mile of 200 square miles of the Brahmaputra river and 87·29 linear miles of boundary survey between Goálpára and the Gáro Hills for the Bijni Ráj Estate.

267. In district Sylhet the disforested area was enclosed by a main circuit, but the *Ilám* lands were so scattered that no attempt was made to connect them by traverses or enclose them in a main circuit. In Goálpára, *Mauza* Guma was enclosed by a main traverse and in Lakhimpur the area surveyed topographically was enclosed by a main traverse subdivided into eight blocks.

268. Altogether 138 observations for azimuths were made to check the angular work; of these, 8 were to the sun.

The origins of survey adopted for the different districts are given below and are the same as used by the late No. 6 Party :—

Sylhet	Lat.	24° 30′
	Long.	92° 0′
Goálpára	Lat.	26° 30′
	Long.	90° 30′
Lakhimpur	Lat.	26° 30′
	Long.	94° 30′

269. The topograpical survey during the season was confined to the Brahmaputra river and was based solely on theodolite traverses. The area to be surveyed during the year was 200 square miles, but owing to a sudden and great rise in the river the survey of one block of 29 square miles had to be abandoned. The area actually surveyed topographically was 171·01 square miles, and cost ₹1,754-8-1 or ₹10·26 *per* square mile.

270. The Ráni of Bijni had petitioned the Chief Commissioner for a survey and demarcation of certain lands situated on the boundary of the Gáro Hills, and one sub-surveyor was employed on this work during the entire season. Altogether 70·59 linear miles were traversed in connection with this boundary and 13 azimuths were observed to check the angular work.

The cost of this work has been included under that of traverse and has in the first instance been debited to the Imperial share of the budget. Adjustment will have to be made when the work is completed.

271. In all only 93 permanent marks were erected by the survey detachment, *viz.*, 68 in Sylhet and 25 in Lakhimpur.

Line-clearing in the disforested tracts in district Sylhet was carried out by the local authorities and not by the survey detachment. A sum of ₹2,000 was expended on clearing the external limits of 60 square miles. Ten blocks of the Langái disforested area will have to be remeasured during the coming season, owing to the traverses not proving within the percentage of error permissible by departmental rules.

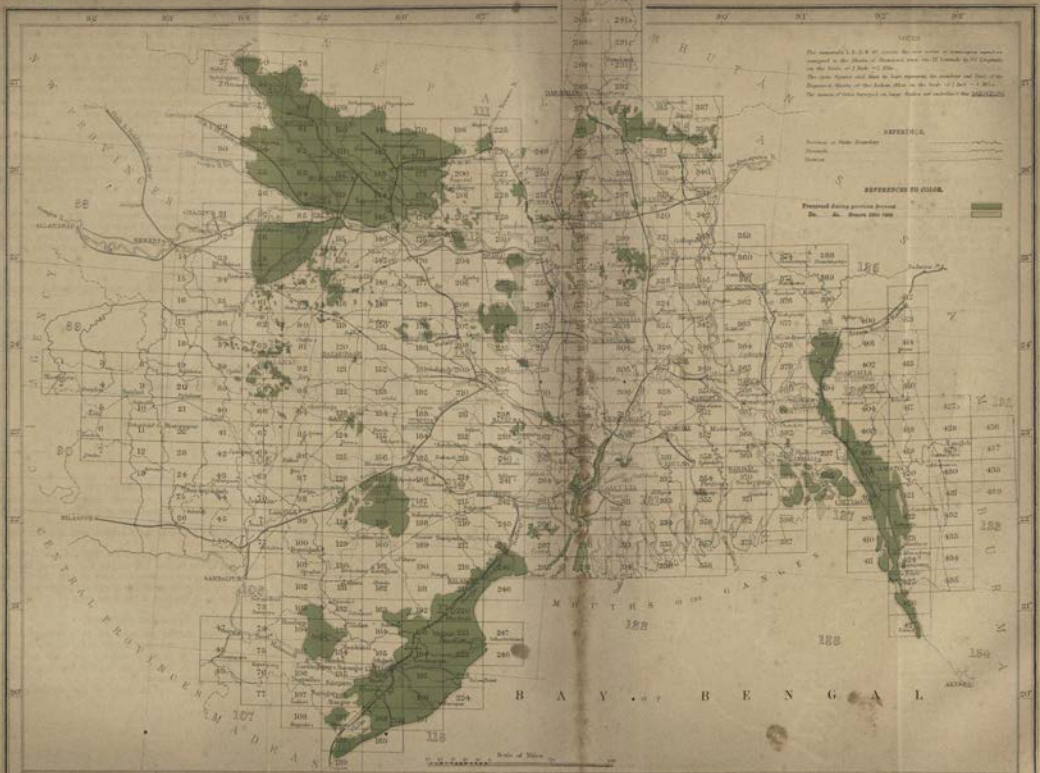
272. The following is the traverse survey completed during the year under report :—

District.	Number of blocks.	Area in square miles.
Lakhimpur	39	200·19
Goálpára	63	48·13
Sylhet	25	15·43

BENGAL SURVEY.

INDEX TO THE TRAVERSE SURVEYS IN BENGAL.

1899-1900.



In Goálpára 70·59 linear miles were traversed in connection with the Goálpára-Gáro Hill boundary.

273. Skeleton traverse plots on scale 16 inches = 1 mile of areas to be surveyed by local agency were supplied to the authorities concerned. In Goálpára 63 villages on 68 sheets; in Sylhet 25 villages on 28 sheets, and in Lakhimpur 39 villages on 43 sheets The plots of Goálpára and Sylhet were supplied so that surveys could be completed during the field season.

274. The additional duties the Superintendent is expected to perform are:—

(*a*) Inspection of settlement maps and records kept by *mandals*, *patwáris*, and *kánungos*, of which there are nearly 1,200 in the province.

(*b*) Instruction of civilian officers and subordinates in practical surveying for one month in the year.

(*c*) Examining the students of the survey schools for first class certificate at Gauháti twice a year, and at Dibrugarh and Jorhát once a year.

(*d*) Inspecting and reporting on the examination papers of the candidates at the quarterly term examinations held at each of the survey schools for second class certificates.

The Superintendent will also be required to supervise the compilation and revision of the standard topographical maps of the province, as new material for the same is received from time to time, but no decision has yet been arrived at by the local Government as to the location of a drawing office for this purpose.

BENGAL.

275. The following were the traverse surveys carried out in Bengal this season:—

District and Estate.	Outturn in square miles.
Sonthal Parganas district (Dáman i-koh Government Estate) . . .	625
Ditto ditto (Private Estates)	134
Noákháli district	68
Sháhabad „ (Semri and Lakhan Dehra Estates) . . .	7
Do. „ (Arrah Town)	2
TOTAL . .	836

In addition to the above the following were also carried out:—

(*a*) Relaying and demarcating with permanent marks, the trijunctions of village boundaries in the Sáran-Patna *diára* for the Collector of patna.

(*b*) Relaying the boundary between the Kachuár and Banskatti *mahál*s in the Sháhabad district.

(*c*) Relaying a disputed boundary between the Binda *diára* Government Estate and that of the Banaili Ráj for the Collector of Monghyr.

(*d*) Laying down and surveying reference marks on the Nepál-Bhágalpur boundary for fixing the positions of certain points on the boundary which now lie in the bed of the Kosi river.

SONTHAL PARGANAS DISTRICT.

276. The operations in this district are confined to a village boundary traverse survey as far as this department is concerned, the cadastral survey being carried out by the Settlement Department.

Personnel.

Mr. E. F. Berkeley, Extra Assistant Superintendent, 6th grade, in charge.

19 Sub-Surveyors and 17 Computers, Draftsmen, etc.

The *locale* of the operations is the

Government estate of Dáman-i-koh and certain scattered private estates for which application for the settlement of rents had been received. As the survey of the latter is paid for by the estates themselves, it has been treated as a separate operation, though the two surveys were carried out by one detachment under Mr. Berkeley. The recess office which is located at Dumka closed on the 20th October 1899 and re-opened on the 1st June 1900.

277. The health of the establishment was very indifferent. Out of an average number of 17 surveyors, an average of 10 were sick each month. Four *khalásis* died during the field season and many others were invalided.

278. The origin of survey is the same as that employed last season. Demarcation was fairly good. Traverse stations have been marked in the same way as in other parts of Bengal.

Dáman-i-koh Estate.

279. The only previous survey that has been carried out of this estate is a rough one done by local agency through settlement *kánungos*. There are two classes of inhabitants, Sonthális and Paháarias, the former inhabit the more open country while the latter are mostly to be found in the hilly parts. The Paháarias have only been subject to a poll-tax heretofore and consequently view the present operations with distrust and offered a considerable amount of opposition. Their lands were therefore only traversed in blocks separating them from the Sonthali villages.

280. The portion of this estate traversed this season lies in the Dumka, Godda and Pakaur sub-divisions. The area traversed is 624 square miles and contains 920 villages and 12 blocks, which were divided into 4 main and 22 sub-circuits. The number of stations is 18,861, of which 1,728 were village boundary trijunctions and were marked by stone prisms; 873 were marked by clay cylinders and 16,260 by wooden pegs.

281. The country was very hilly throughout, with small plateaux here and there, which were generally cultivated, as also were the valleys. There were no connections with the Great Trigonometrical Survey as none fall into the area traversed, but the work was connected with that of the previous season. Azimuths were observed at 120 stations; an average of an azimuth to every 20 miles.

282. The cost-rate for the season's work in the Dáman-i koh is R43·6 *per* square mile, including stone embedding, and is almost the same as last year's rate.

Private Estates.

283. The following statement gives the area traversed and the *tálukas* in which the work lay:—

Sub-division.	Táluka.	No. of villages.	Area in square miles.
Dumka	Nankar	73	45·2
	Sap Challa	49	29·3
	Tesuria	35	22·0
	Amgáchi	7	8·9
	Ghát Rasikpur	7	2·8
Rájmahál	Mansa Chandi	17	5·9
	Miánpur		
	TOTAL	188	114·1

• Also one block of 20·3 square miles.

The above have been divided into 2 main and 2 exterior circuits. The number of stations is 3,185, of which 394 are marked by stones and 2,791 by pegs. Azimuths were observed at 35 stations, giving an average of an observation to about every 15 linear miles of chaining. There was one connection with the Great Trigonometrical Survey, *viz.*, with Satbor H. S. No. 3 of the Malúncha Series, which gives an error in the chaining of 1·26 feet per mile. The 16-inch plots were supplied to the Settlement Officer during the field season.

284. The cost-rate for the season is ₹20·6 *per* square mile, which includes stone embedding and certain sums spent on the completion of computations of the private estates traversed the preceding season.

NOÁKHÁLI DISTRICT.

285. The operations in this district consisted of a boundary survey with theodolite and plane-table of certain *chars* or islands on the coast with the object of ascertaining their area and suitability or otherwise for cultivation. The area traversed is 61·8 square miles and the limits of the islands were mapped with the plane-table on the 4-inch scale, adding another 5·7 square miles. The origin of survey is the same as was employed in 1896-7 when portion of the district was cadastrally surveyed, *viz.*, the intersection of the meridian 91° 30′ E. longitude with the parallel of 22° 30′ N. latitude. The work was connected with 3 stations of the East Calcutta Longitudinal series of the Great Trigonometrical Survey and with the traverses of the recent survey. The number of traverse stations is 556, of which 27 have been marked by large stone pillars 6 feet in length, provided by the Collector, 25 with large pottery cylinders and the rest by pegs.

Personnel.

Mr. T. W. Babonau, Sub-Assistant Superintendent, 1st grade, in charge.
3 Sub-Surveyors.
1 Inspector.
3 Amins.

MISCELLANEOUS SURVEYS.

286. In the Patna-Sáran *diára* permanent marks were embedded at trijunctions of village boundaries. The area was traversed and surveyed the previous season but permanent marks are not ordinarily employed in *diára* lands and these were put down at the special request of the Collector.

287. The demarcation of the boundary between the Kachuár (private) and Banskatti (Government) *mahálś* was completed this season. The marks were provided by the Collector of Sháhabad and there were altogether 271, of which 69 were masonry pillars, 121 large dressed stones, 5 feet long, and 51 small dressed stones. The boundary of a small neighbouring Government estate—Murli Hill—was also demarcated at the Collector's request, in which 15 stone marks were embedded. This work was carried out by Sub-Surveyor Dharnidhar Mukerji, and the Collector expressed himself well satisfied with the way in which it was carried out.

288. The traverse surveys of Arrah Town and the Lakhan Dehra estate were done for the Collector of Sháhabad. The area of the former is 2 square miles and that of the latter 7.

289. Twelve reference marks were laid down in order to fix the positions of certain points in the Nepál-Bhágalpur boundary, which now lie in the bed of the Kosi river. The positions of these marks were only temporarily marked at the time with wooden pegs, and it was arranged that the Sub-Divisional Officer of Supaul should put up the permanent marks. He was furnished with a map showing their positions, and a similar map was also given to the Nepálese representative. This work was carried out by Captain A. Mears.

PROGRAMME FOR 1900-1901.

290. The programme of purely traverse surveys in Bengal for next season is:—

(i) Completion of the Dámin-i-koh Estate, Sonthal Parganas, 700 square miles.

(ii) An area of 600 square miles in the Porahát, Khera and Bandgaon Estates in Singbhum.

(iii) The Deo and Maksudpur Estates in Gaya; about 200 square miles.

and several petty miscellaneous surveys.

CENTRAL PROVINCES.

CENTRAL PROVINCES DETACHMENT.

291. The detachment continued to be employed on traverse surveys as required by the local Administration for the purpose of providing plots on the 16-inch scale for a cadastral survey to be carried out by *patwáris*.

Personnel.

Mr. W. C. Price, Extra Deputy Superintendent, 2nd grade, in charge.
Mr. M. Gastaud, Extra Assistant Superintendent, 6th grade, from 7th September.
10 Sub-Surveyors, 8 Computers, 4 Draftsmen, and 1 Writer.

Recess work was closed at Jubbulpore on the 1st of November 1899 when the detachment proceeded to Narsinghpur, the headquarters for the field season. From this starting point the sub-surveyor's squads diverged for field operations to the different districts, where their work was inspected and tested from time to time by the officer in charge. The detachment returned to Jubbulpore on the 1st June 1900.

292. The programme of work for the season was as follows:—Continuation of the traverse survey in the *jágirs* of Chhindwára and Hoshangabad districts, 203 square miles in the Harsud *tahsil* of district Nimár, and other miscellaneous work under the orders of the local Administration. In October the Commissioner of Settlements and Agriculture addressed the Deputy Commissioners of the districts to be operated in, enquiring if famine and the deficient water supply would make it impossible for survey work to be carried out, and remarked that in the event of its having to be deferred, he could provide a good deal of work in the *zamindáris* of Raipur and Biláspur. Later on in the same month, he telegraphed that the water supply was likely to last till January only, but as the programme had been arranged, and any deviation would entail extra expense and loss of time, it was considered inexpedient to depart from it.

CHHINDWÁRA DISTRICT.

293. Eight sub-surveyors were employed in the *jágirs* of this district for the first half of the season, and then half that number were deputed to other districts. The traversing was in very rough, hilly country, the jungle being very heavy and villages small, few and far between, the greater number being deserted, but the *jágirdárs* gave good assistance and carried out their own demarcation, as the work progressed. Seasonable rain fell in January, thus enabling the surveyors to continue in the district and complete the large outturn of 635 square miles.

HOSHANGABAD DISTRICT.

294. Of the two *jágirs* in this district to be traversed, only one, *viz.*, Chháter, was completed. There are blocks of high hills within the work and the villages were not demarcated, but men went round with the sub-surveyors and pointed out their boundaries. The area traversed was 47 square miles.

NIMÁR DISTRICT.

295. The *raiyatwári* villages of the Charwa tract, lately transferred from Hoshangabad to Nimár, now known as the Harsud *tahsil*, which are intermixed with some of the *málguzári* villages in this area, were traversed, and chiefly based on the traverses of the revenue survey of 1888-89. Twenty-seven villages at the southern end of this tract form a compact block; the rest are scattered and needed a good deal of searching to find the old stations, as the local men could not point them out. Where old stations could not be found, connecting lines from long distances had to be run. The country is not so hilly as in other parts operated in, but famine, scarcity of water and sickness prevailed, and provisions had to be obtained from long distances. The area finished is 203 square miles.

RAIPUR DISTRICT.

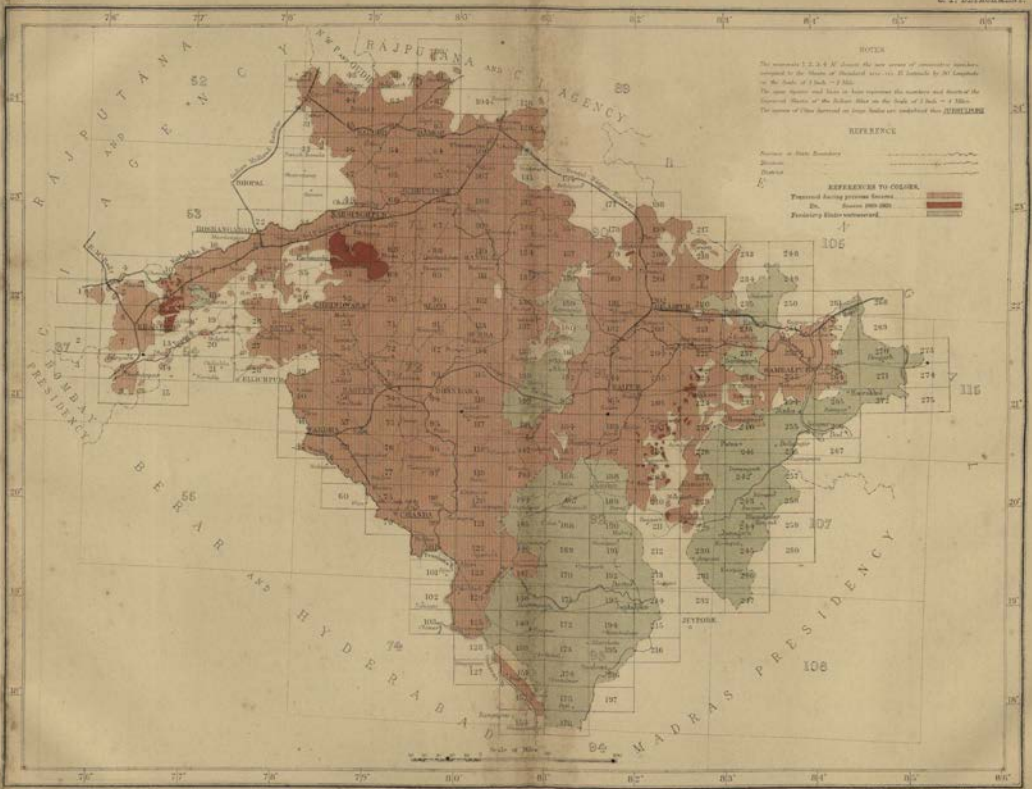
296. Since the surveys of 1892-95, cultivation has extended in the eastern *zamindáris* of this district, owing to the immigration that set in during the famine of 1896-97, and rental assets of plots that fell short of ₹15 before that period have increased, necessitating a survey for the current settlement,

CENTRAL PROVINCES SURVEY.

INDEX TO THE TRAVERSE SURVEYS IN CENTRAL PROVINCES.

1899-1900.

C. P. DETACHMENT.



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No. 550-5-99

which expires on 30th June next. To traverse these isolated patches of cultivation, lines had to be run from the old revenue survey stations in 4 of the south east *zamindáris*, leaving one more *zamindári* for the ensuing season, which could not be taken up, owing to want of time. These excisions were scattered over an area of 5,500 square miles, in a deserted country, where famine and epidemics of cholera and small pox raged. The area traversed was 91 square miles. Other work may probably be given the detachment next season in the north west *zamindáris*, besides the one that remained over in the south-east.

297. The total area traversed was 978 square miles, and the expenditure for the year is R24,972-9-5, giving a cost-rate of R25-8-7 *per* square mile, which includes heavy charges for travelling by rail and road and inspecting the men at work scattered over the province. This includes the cost of the scattered work in Raipur, but excludes the charges for the drawing office, lately sanctioned. The number of mark-stones embedded was 12,169, of the same description as, but nearly 4,000 more, than those put down last year.

298. A boundary dispute between the *zamindáris* of Pendra and Kenda, which could not be traversed by local agency as it lay among the hills, was called for by the settlement officer, and undertaken early in February. The plot on the 16-inch scale, containing an area of 2 square miles, was forwarded immediately after, as the dispute was required to be disposed of quickly.

299. The health of the detachment suffered during the first few months from fever; two sub-surveyors and their squads had to leave their work and proceed to the nearest civil station for medical treatment, thus delaying the work. Two of the *khalásis* died from cholera in the Raipur district, and a sub-surveyor was also attacked, but recovered. Frequent panics from epidemics and drought unnerved the men, the whole country was famine stricken, and the heat after February was excessive. The men were working in some of the worst parts of the Central Provinces this year and did very well considering all the difficulties they had to contend against.

The greater portion of the menial establishment had to be obtained from the North-West Provinces and Bengal, as local men were deserting their homes and seeking employment on relief works, so as to be with their families. Those entertained in the country found survey work irksome, and frequently deserted, as they could earn enough to support themselves in relief camps.

300. The difficulties of scattered work in different districts are numerous. Index maps are sometimes received with the lists of villages to be traversed, but the positions of some villages cannot be shown; all that is known is that they are within a *zamindári* or tract of country. The surveyor cannot therefore be supplied with the data of the stations from which to begin and close work for each village; sometimes there are Revenue, Topographical and Forest Survey stations in the same country, near each other, and also local survey stations, which cannot be identified by the *patwáris* or villagers, and the sub-surveyor has to start work on the nearest he can find, and trust to the data being in office. Very often he has to re-observe his starting and closing traverses, as on setting up his work, it is found he has based it on stations the data of which are not forthcoming. Whenever possible, plots to scale are made and sent out to assist the sub-surveyors.

301. The Commissioner of Settlements and Agriculture, under whose direct orders the detachment is working, wrote "I am glad to see that substantial progress has been made, in spite of many difficulties," and again, "I have much pleasure in acknowledging the good work done by the detachment, in spite of adverse circumstances."

302. The Government of India, in the Revenue and Agricultural Department, in letter No. 421 dated the 16th February, sanctioned the enlargement of this detachment from the beginning of the present financial year, for the recompilation and correction of the topographical maps of the province. Mr. Gastaud and two draftsmen joined in September, and the Drawing Office started work with the standard sheets of the Jubbulpore district. Only the plotting of the half sheets or field sections, on the 2-inch scale, and the reductions by pantagraph of villages cadastrally surveyed, have been begun. As the drawing section commenced work at the close of the season, no progress can be shown in this report.

303. The programme for the coming season consists of:—Traversing, under the orders of the local Administration, in districts Chhindwára, Hoshangabad, Nimár, Raipur and Chánda, the cadastral survey being undertaken by local agency.

The drawing office will continue the compiling of standard maps and checking of local agency cadastral surveys in the field.

304. The detachment was inspected by the Deputy Surveyor-General, Revenue Branch, in the middle of July, at recess quarters in Jubbulpore. Mr. Montgomerie, officiating Commissioner of Settlements and Agriculture, Central Provinces, visited the office also.

At a conference held at Nágpur on the 13th August 1900, when Messrs. Craddock and Montgomerie, and Colonel Hobday were present, it was decided—

(1) That after the traversing of the areas that have never been traversed, and which will be completed in season 1900-1901, the detachment should take up the traversing of the following areas surveyed by local agency based on "triangulation by chaining" and "traverse by compass and indicator" before the material of these surveys can be utilised for incorporation in the standard maps of the province:—

District.	Square miles.
Damoh	41
Mandla	55
Seoni	126
Hoshangabad	76
Nimár	174
Chánda	308
Nágpur	3
Raipur	596
Sambalpur	169
TOTAL	1,548

(2) That the control of the drawing office should rest with the Deputy Surveyor-General, and that it should be located for the present in the Division in which map compilation is being conducted.

PUNJAB.

PUNJAB DETACHMENT.

305. This detachment was formed at the request of the Punjab Government under the orders of the Government of India, contained in Revenue and Agricultural Department letter No. 1952-104-3, dated 24th August 1899, for the purpose of carrying out a traverse survey of trijunctions of village boundaries in district Kohát. It was considered that, by means of the direct distances between trijunctions thus obtained, the village plans done by the *patwáris* on the square system of survey adopted in the Punjab could be checked, and the *patwáris'* maps utilised in the preparation of standard maps of the province.

Personnel.

Mr. R. B. Smart, Extra Assistant Superintendent, 1st grade, in charge.
Mr. G. C. Swiney, Extra Assistant, Superintendent, 4th grade, from 9th October 1899.
17 Sub-Surveyors, 16 Computers and 1 Hospital Assistant.

306. The area required to be traversed this season was 2,757 square miles, out of which 2,530 square miles were completed: the balance 227 square miles containing three villages, according to the last settlement, could not be done, as it was considered desirable to sub-divide the same into several villages, of which the demarcation had not been carried out.

307. After taking over all instruments and camp equipment from Nos. 2 and 8 Parties at Mussooree the detachment assembled at Saháranpur at the

* Mr. Price reports that Mr. Gastaud understands his duties thoroughly and is a very willing assistant. The native staff worked satisfactorily, the following are favourably reported on: Preonath Banerji and Vishun Sitaram, Computers; Karim Baksh, Draftsman; C. Paupiah, Writer; and Abdul Wahid, Hafizulla and Murad Ali, Sub-Surveyors.

PUNJAB SURVEY.

1899-1900. INDEX TO THE TRAVERSE SURVEY IN DISTRICT KOHAT. DETACHMENT.

No. 481-S. 00.

end of September, and reached Khushálgarh on the 30th in time to take over additional camp equipment and instruments which had arrived from Azamgarh the previous day, thus permitting the despatch of every thing to Kohát where the detachment arrived on the 1st November. On arrival, intimation was received from the Deputy Commissioner that no surveyors should be out at work after 4 P.M. This necessitated a delay of a week to enable them to learn how to observe to the sun instead of the stars for azimuth, so that they did not leave camp before the 7th, reaching their ground by the 12th November.

308. The season's outturn is given in the following table :—

Parganas.	Number of villages.	Area in square miles.
Hangu	35	437
Teri Khattak	96	792
Teri Barak	70	824
Kohát	91	477
TOTAL	292	2,530

The above areas have been obtained from the last settlement returns, as the boundaries were not followed to allow of the traverse areas being given as usual.

309. The positions of 571 trijunctions were determined and the direct distances between trijunctions calculated in feet were supplied to the Settlement Officer. The total number of direct distances thus calculated is 785. Plots on the scale of 4 inches to a mile of 292 villages were also supplied to the Settlement Officer, and traces showing the positions of the trijunctions of villages with direct distances in feet. Forty one plots on scale 16 inches to a mile and 97 plots on scale 24 inches to a mile were also supplied. These plots were asked for in order to ascertain whether the *patwáris* could utilize them, but as the villages selected for this experiment were situated in hilly tracts, more suitable ones were chosen, plotted, and sent, but the result of the experiment has not been communicated, and as no further plots have been requisitioned, it is presumed the experiment was a failure. The Settlement Officer apparently decided to check the direct distances between trijunction points only by means of the distances supplied to him, but as the average size of the villages is 8·6 square miles, which, when plotted on the large scale of 16 and 24 inches to the mile, extend over several sheets, it will hardly be possible to get the trijunctions in their true positions by means of direct distances only. If the *patwáris* have shown the traverse stations on their maps there will be some check on the work done by them in a hilly district like Kohát, but whether these orders given by the Settlement Commissioner in his note dated 3rd December 1899 have been attended to or not, is not known.

310. During the field season the plans of two villages were sent by the Settlement Officer to be checked. One was altogether wrong, the trijunctions in the hilly tracts being completely out of position, the other which was situated in fairly level ground was better, but even here one of the platforms was out about 300 to 400 feet. In neither of the above villages were the survey traverse stations shown, by which any error in mapping could be located, the maps being copies of the last settlement survey with the limits of fields corrected to present possession.

311. The programme would have been completed much earlier had the work been located in any other but a frontier district where the sub-surveyors and *khalásis* were unable to get about without the guards supplied by the head men of villages. No one was allowed to encamp away from the village site, and as the villages were large and the trijunctions situated at great distances from the village sites, much time was lost in going to and coming from work.

312. It is very doubtful whether either of the objects aimed at in these operations, *viz.*, the checking of the *patwáris* maps or their utilization for topographical purposes, have been attained.

As regards the first, the direct distances between trijunctions have been furnished to the settlement officers, but in the hilly ground which forms so much of the district, the *patwáris* do not profess to be able to fix the positions of trijunctions accurately, as the square system of survey is inapplicable. It is only in the flat portions of the district where the *patwáris* have been able to survey on their usual system that any valuable check can be applied, and this will only be the case, if they have shown the traverse points in addition to the trijunctions on their maps, thus giving more points of reference. It seems doubtful, however, if this has been done. A still better system would have been for traverse operations to have been conducted after the *patwáris* had laid down the squares required in their survey system. The traverse surveyor could then have fixed the corners of some of their squares as well as the trijunctions, which would have enabled a far better test to be applied.

313. As regards the second point, the utilization of the results for topographical purposes, we already possess excellent topographical maps of the district, surveyed in 1880-83. These are now somewhat out of date and do not shew the village boundaries and it is to correct these two points that the settlement maps are looked to. The traverses give the geographical position of the trijunction points, but if the *patwáris'* maps are turned to, to locate these trijunctions, that is to say, to decide whether they are situated on a ridge, spur, valley or any other natural feature, it is found that the hills are not mapped by the *patwáris* and no clue is given to the positions of the points. Even were the trijunctions accurately located, the roughly sketched village boundaries cannot be entered on the existing topographical maps as, when the boundary is corrected to fit between the trijunctions, it is not possible to say where it should fall with reference to the natural features of the ground. Similarly little or no use can be made of the *patwáris'* maps to fill in changes in village sites, etc., as owing to the discrepancies in the positions of trijunctions it is not possible to locate the details.

314. The angular work was checked by 88 azimuths observed to the sun. There were no stations of the Great Trigonometrical Survey in the work, but the traverses were connected with the stations of the Kohát topographical triangulation, the average difference between traverse and trigonometrical distances being 5·6 feet per mile.

315. The cost of these operations for the survey year ending 30th September 1900 has been R44,750-2-8, giving a cost-rate of R17-11-0, *per* square mile, which would have been less but for the heavy expense incurred in moving the camp equipment from Azamgarh to Kohát, and the railway fares for menial establishment from Saháranpur to Khushálgarh. The high rates of wages for *khalásis* and *tindals* have also contributed largely to the cost, the wages in the Punjab being R 8 and 10 per mensem against R 4·8 and 6·8 in the North-Western Provinces.

316. The health of the establishment was fairly good, the principal maladies being bowel and chest complaints, the former, no doubt due to scarcity and bad water in the Teri *iláqa*, and the latter, to the abnormal amount of rain during the winter months. Two deaths occurred during the season, both being attributable to pneumonia.

317. The detachment was inspected by Major Longe, Officiating Deputy Surveyor-General in May and by Colonel Hobday, Deputy Surveyor-General in September 1900. The Surveyor-General also visited the recess office with reference to future operations in the Punjab connected with the riverain surveys which are contemplated.

318. During the ensuing field season it is proposed to continue similar traverse operations in district Hazára and to complete the balance of 227 square miles remaining in Kohát. In addition to this, the Punjab Government desire this detachment to take up, as an experiment, the laying down and traversing of permanent marks along the riverain area of the Chenáb river in districts Mooltán and Muzaffargarh.*

* Mr. Smart reports that Mr. Swiney has worked well, and taken a great interest in all his duties. The native establishment has given satisfaction, especially Sub-Surveyor Salamat Ali. All the Computers have worked well, as also Writer Fattah Muhammad.

GEODETIC.

ASTRONOMICAL LATITUDES.

No. 22 Party.

319. This party, under Lieutenant Tandy, was employed on latitude operations on the Biláspur Meridional Series. The party left Dehra Dún on November 20th 1899, and returned on March 25th 1900. The instrument used was Troughton and Simms' Zenith Telescope No. 1. Talcott's method of observation was employed and the following six latitudes were observed :—

Personnel.

Lieutenant E. A. Tandy, R.E., in charge up to 18th April 1900.
Lieutenant H. McCally Cowie, R.E., in charge from 19th April 1900.
Babu Hanuman Prasad, Sub-Assistant Superintendent 2nd grade.
2 temporary Computers and 1 Hospital Assistant.

TABLE I.

Name of Station.	Series.	Geodetic latitude. $=\lambda_c$	Astronomical latitude. $=\lambda_o$	Apparent deviation of plumb line. $=\lambda_o-\lambda_c$
		° ′ ″	° ′ ″	
Amúa	Calcutta Longitudinal.	23 59 56·24	23 59 57·10 ±0·052	+0·86
Karia	Biláspur Meridional.	19 12 5·98	19 12 2·74 ±0·054	−3·24
Háthbena	,,	19 51 42·34	19 51 42·70 ±0·078	+0·36
Ramai	,,	20 56 51·47	20 56 50·36 ±0·076	−1·11
Patháidi	,,	21 48 45·97	21 48 43·11 ±0·063	−2·86
Dalea	,,	22 19 33·62	22 19 30·31 ±0·070	−3·31

320. After the latitude season of 1893-94, it was decided to attach two levels to the zenith telescope for Talcott work. The errors of Talcott latitudes were believed to be partly due to the level not showing true dislevelments, and it was considered that the addition of a second level would both improve the results and give the observer a greater power of analysing them. Owing, however, to the astronomical parties being employed in 1895 and 1896 on the Perso-European Longitude Arcs, latitude work fell into abeyance, and the proposed addition of the second Talcott level was not carried out till 1898. In the meantime the question of calibrating levels had been raised, and in the discussion that ensued the important advantages of the 2nd level were to a great extent lost sight of. In the two following tables the latitude results of 1898-99 have been computed (firstly) by using each level separately, and (secondly) by using both levels together: in the same tables the latitude results are given (firstly) when a

calibration diagram is employed for each level, and (secondly) when mean values for the divisions of the scales are adopted :—

TABLE II.

Name of Station.	Series.	Astronomical latitude and p. e. with level correction taken from the diagram.			Astronomical latitude and p. e. with level corrections determined by use of a mean value.			Diagram—Mean value.	
		By Level No. 6.	By Level No. 9.	Level No. 6—No. 9.	By Level No. 6.	By Level No. 9.	Level No. 6—No. 9.	The corrections being taken from level No. 6.	The corrections being taken from level No. 9.
		° ′ ″	″	″	″	″	″	″	″
Vizagapatam	East Coast Series.	18 0 56·72 ±0·070	56·63 ±0·066	+0·09	56·64 ±0·085	56·80 ±0·073	—0·16	+0·08	—0·17
Ráwal	,,	18 32 4·69 ±0·093	4·64 ±0·064	+0·05	4·95 ±0·103	4·67 ±0·069	+0·28	—0·26	—0·03
Mal	,,	18 47 6·75 ±0·060	6·71 ±0·064	+0·04	6·68 ±0·066	6·67 ±0·075	+0·01	+0·07	—0·04
Khundábolo	,,	19 51 6·92 ±0·082	7·24 ±0·055	—0·32	7·09 ±0·074	7·12 ±0·061	—0·03	—0·17	+0·12
Cuttack	,,	20 28 52·13 ±0·068	52·04 ±0·053	+0·09	52·16 ±0·063	52·02 ±0·052	+0·14	—0·03	+0·02
Chandipur	,,	21 26 34·02 ±0·065	33·80 ±0·063	+0·22	34·00 ±0·070	33·95 ±0·063	+0·05	+0·02	—0·15
Patna	,,	21 47 17·36 ±0·055	17·34 ±0·050	+0·02	17·28 ±0·052	17·33 ±0·048	—0·05	+0·08	+0·01
Dariápur	,,	21 47 28·78 ±0·064	28·79 ±0·054	—0·01	28·95 ±0·059	28·75 ±0·054	+0·20	—0·17	+0·04

TABLE III.

Name of Station.	Series.	Astronomical latitudes and p. e.			Geodetic Latitude.	Apparent deviation of plumb line.
		With Level corrections as given by the diagram.	With Level corrections determined from a mean value.	Diagram. Mean value.		
			λ_o		λ_c	$\lambda_o - \lambda_c$
		° ′ ″	° ′ ″	″	° ′ ″	°
Vizagapatam	East Coast Meridional.	18 0 56·62 ±0·057	18 0 56·73 ±0·068	—0·11	18 1 2·91	—6·18
Ráwal	,,	18 32 4·64 ±0·065	18 32 4·83 ±0·079	—0·19	18 32 9·22	—4·39
Mal	,,	18 47 6·73 ±0·063	18 47 6·79 ±0·059	—0·06	18 47 16·97	—10·18
Khundábolo	,,	19 51 7·33 ±0·050	19 51 7·10 ±0·059	+0·23	19 51 12·50	—5·80
Cuttack	,,	20 28 52·03	not yet determined		20 29 0·68	—8·65
Chandipur	,,	21 26 33·93 ±0·60	21 26 33·98 ±0·060	—0·05	21 26 36·99	—3·01
Patna	,,	21 47 17·35 ±0·039	21 47 17·30 ±0·045	+0·05	21 47 20·83	—3·53
Dariápur	,,	21 47 28·80 ±0·052	21 47 28·85 ±0·051	—0·05	21 47 27·95	+0·90

321. It is necessary, if the advantage of the introduction of a second level is to be ascertained, to omit from consideration for the moment, questions of calibration and mean value. In connection with the second level two enquiries

present themselves, *viz.*, (i) Is the probable error of a final value of latitude sensibly improved when the level correction of each observation is determined from two levels? (ii) Is the final value of latitude found to be appreciably different according as when the first or the second level is employed in the computations? The average probable error of a latitude when Level No. 6 alone is used is ± 0.070″, and when Level No. 9 alone is used is ± 0.060″: the average probable error of a latitude, when both levels are used, is ± 0.054″. From this analysis it would appear that Level No. 9 is a superior instrument to Level No. 6; and if Level No. 9 were being employed alone but little advantage would accrue from the addition of Level No. 6, the probable error of result being only reduced by 0.006″. If Level No. 6 were, however, the only level in use, the probable error of result would be reduced by 0.016″ by the addition of Level No. 9.

When the differences in the final values of the latitudes as derived from the two levels separately come to be considered, the advantage of having a second level is more evident. In the fifth column of the above Table II are given the differences in the values of the several latitudes when computed with No. 6 Level only and when computed with No. 9 Level only: two of these differences exceed 0.2″ and one exceeds 0.3″. As long as such large discrepancies are brought to light the employment of a second level must be considered profitable, notwithstanding the comparative small diminution that obtains in the probable error. It is noteworthy, however, that in the case of the pair of levels mounted on the zenith sector, with which No. 23 Party was equipped, the difference in the values* of the latitude by individual levels never exceeds 0.10″ (*vide* appendix page 9).

322. From the figures in the above tables evidence may also be obtained as to the relative merits of employing a calibration diagram or a mean value for the deduction of the level corrections. The average probable error of a latitude, when a calibration diagram is used, is ±0.057″, and when a mean value is adopted, is ±0.060″: if Level No. 6 be alone employed, the probable error of a latitude when calibration is used is ±0.070″, and when a mean value is adopted, is ±0.071″: if Level No. 9 be alone employed, the probable error of a latitude when calibration is used ±0.058″ and when a mean value is adopted is ±0·062″. The adoption of a calibration diagram has thus apparently reduced the probable error of a latitude by about 0.003″. It is peculiar that this diminution in the case of No. 6 Level is 0.001″ and in the case of No. 9 Level is 0·004″, whereas No. 9 Level is presumably the superior level of the two, and the improvements resulting from calibration are expected to be more apparent when it is used with inferior levels.

323. In the fifth column of Table III are given the differences in the final values of latitude, as derived from both a calibration diagram and an adopted mean value: the arithmetical mean discrepancy is 0.07″, the algebraical mean discrepancy is −0.03″. In the case of Khundábolo the discrepancy is the largest, and amounts to +0.23″; it is difficult, however, to attribute this discrepancy to errors arising from the adoption of a mean value, for if the results at Khundábolo, as given in Table II, are examined, it will be seen that the values of latitude when a calibration diagram was used differed by no less than 0.32″ according as the first or second level was employed in the computations, whereas the results when a mean value was adopted only differed by 0.03″. As far as the evidence goes, the value of latitude for Khundábolo resulting from an adopted mean value is a more reliable measure than that resulting from calibration. It is useless to discuss minute diminutions of probable error in the third place of decimals of a second, when a final value of latitude may vary by 0.32″ according as the first or second level is used.

324. The experiments on calibration have been very valuable in showing that the adoption of a mean value does not cause the serious errors that were at one time feared. A mean value must, however, be used intelligently and must be regarded as fallible: Level corrections must be kept small, and endeavours must be made to balance corrections with a positive sign against those with a negative. The recognised fallibility of an adopted mean value, necessitating a system of balancing positive and negative corrections, is possibly an inherent source of strength to the mean value method, for a calibration diagram admits of no cancelment and must be accepted as absolute and exact.

* These values were computed by Captain Lenox-Conyngham using mean values for divisions of the level scales.

325. The calibration diagram is very ingenious and reflects great credit on Lieutenant Tandy, its inventor; it enables levels to be more minutely examined and tested than heretofore, but whether the calibration method will be of practical utility in latitude work has not yet been demonstrated: just as in the past the mean value of a division of a level has been found to be an ever varying quantity so is the calibration of a level, however carefully recorded in a diagram, found liable to constant change. Even if these changes come to be explained and remedies for them discovered, the calibration system will still have two disadvantages to contend with: the preparation of a diagram will always involve great labour and no finished work will admit of future re-examination, unless a copy of the diagram is forthcoming. To accept a diagram as permanently correct for all time will be contrary to the traditional methods of the Great Trigonometrical Survey of India, and yet to check it annually will be an arduous undertaking. Copies of the diagrams appertaining to all levels will have to be attached to every computation and will have to be printed in the published volumes. These disadvantages of the calibration system are by no means insuperable, but before that system can be adopted for latitude work, it must be shown to possess compensating advantages. Before observers will willingly undertake the labours of calibrating and re-calibrating, and before computers will willingly accept the additional complication of measuring corrections from a diagram, it will have to be shown—and this has not yet been done—that results are appreciably improved by these steps, and that the mean value system is sensibly inferior.

The party was inspected by the Superintendent, Trigonometrical Surveys, in June 1900.

No. 23 PARTY.

326. The personnel of the party was the same as during the season 1898-99, except that two computers were engaged in November, the one with a view to being employed permanently, the other as a temporary measure only.

Personnel.

Captain G. P. Lenox-Conyngham, R.E., Deputy Superintendent, 1st grade.
1 Sub-Surveyor, 2 Computers and 1 Writer.

The party left recess quarters on October 27th, 1899, and returned thereto on May 14th. The unusual lateness of the latter date was due to the base-line operations, which took longer than had been anticipated.

327. The programme of work proposed for the party consisted of determinations of latitude at 2 stations on the Great Arc series, 5 on the Budhon series and 3 on the Rangir series, the object in view being the examination of the variation of Himalayan attraction on those series whose northern ends abut against the Himalayan mountains. The existing information on this subject is scanty and the indications conflicting. The apparent attraction is always less than would have been anticipated and in some places, for instance in the neighbourhood of Amritsar, it seems to disappear altogether. But the fact must not be lost sight of that the attractions as determined are based on the assumption that the Himalayan mass exercises no effect on the direction of gravity at the station of Kaliánpur the origin of the survey. This assumption has been necessary as a working hypothesis, though there are reasons for doubting its correctness. There are fortunately a large number of series of triangles which run southwards from the foot of the Himalayas, so that it will be possible to investigate the relations between the attraction and the distance of the hills at a number of points. The only trustworthy data available for the solution of the problem of Himalayan attraction are the *decreases* in the apparent values of the attractions as the observer recedes further and further from the Himalayas: attention in the future must be confined to these decreases only, and the absolute values must be considered to contain an unknown constant error.

328. During the winter the new apparatus for measuring base-lines by means of suspended wires, designed by M. Jâderin, arrived from Stockholm; and early in March No. 23 Party was withdrawn from the latitude operations in order that it might take part in an experimental measurement of the Dehra Dún base-line. The result of the measurement is so far inconclusive; for the co-efficients of expansion which were used in the computation are now known to have been wrong. In the absence of any means of determining these

co-efficients it was considered safe to assume that the wires were similar to those used by M. Jäderin and to adopt the values of the constants given by him in his pamphlet. It soon became evident, however, that these were inapplicable, and a reference to the makers has elicited the information that the steel wire is made of an alloy of nickel and steel, the expansion of which is very much lower than that of any metal hitherto used for such a purpose. Until the co-efficients of both wires have been carefully re-determined nothing can be said as to the merits of the system.

329. In consequence of the Base measurement the latitude determinations on the Rangir series were abandoned, but those on the Great Arc and the Budhon series were completed. The instrument used was Strange's Zenith Sector No. 1. It had shewn defects during the season 1898 99, but the measures taken to correct them, *viz.*, the provision of a second independent level and of an additional clamp to the old level, seem to have been effectual for the results obtained during the present season are satisfactory.

330. Table of observed and computed Latitudes :—

Station.	Observed latitude.	Computed latitude.	Observed—Computed.
	Budhon Series.		
	° ′ ″	° ′ ″	″
Sarkára	29 15 35·12 ± 0·060	29 15 46·92	— 11·80
Sirsa	28 54 30·30 ± 0·044	28 54 39·64	— 9·34
Bánsgopál	28 33 23·31 ± 0·050	28 33 28·07	— 4·76
Sankráo	28 2 28·95 ± 0·049	28 2 28·99	— 0·04
Salimpur	27 46 36·26 ± 0·048	27 46 36·46	— 0·20
	Great Arc Series.		
	° ′ ″	° ′ ″	″
Nojli	29 53 14·12 (observed in 1864).	29 53 27·76	— 13·64
Kaliána	29 30 47·98 (observed in 1840).	29 30 54·70	— 6·72
Datairi	28 43 58·67 (observed in 1864).	28 44 4·49	— 5·82
Bostán	28 30 54·28 ± 0·060	28 30 59·64	— 5·36
Chandaos	28 5 0·74 ± 0·049	28 5 1·59	— 0·85
Noh	27 50 53·13 (observed in 1864).	27 50 53·08	+ 0·05

331. The results seem to show that superimposed on the great attraction of the Himalayas there are purely local attractions of considerable magnitude. Thus we have (*vide* table) a drop of 7″ in 22 minutes of latitude between Nojli and Kaliána, a further drop of only 1·4″ in the next degree and then a drop of 4·5″ in 26 minutes. This is on the Great Arc. On the Budhon series the behaviour is somewhat more regular, though here also the rate of change does not seem to follow any law. The detailed examination of an area in crossing which a large change takes place seems to be the next step indicated. A more detailed account of the work done and an interesting discussion of the results by Captain Lenox-Conyngham will be found in the appendix.

332. The health of the party was good throughout the season. One man died, but from causes not connected with general health.

The party was inspected in Mussooree by Major Burrard, Superintendent of Trigonometrical Surveys, on June 19th, 1900.

TIDAL AND LEVELLING OPERATIONS.

No. 25 Party.

Personnel.

Lieutenant H. L. Crosthwait, R.E., Officiating Deputy Superintendent, 2nd grade, in charge up to 19th September 1900.

Lieutenant H. M. Cowie, R.E., Assistant Superintendent, 2nd grade, up to 19th April 1900.

Mr. G. Belcham, Extra Deputy Superintendent, 2nd grade, up to 15th February 1900.

Mr. E. J. Connor, Extra Assistant Superintendent, 2nd grade, in charge from 19th to 30th September 1900.

Mr. T. Shaw, Extra Assistant Superintendent, 4th grade, up to 5th May 1900.

Mr. J. P. Barker, Extra Assistant Superintendent, 5th grade.

" H. G. Shaw, Sub-Assistant " 1st " from 26th September 1900.

Mr. E. H. Corridon, " " 3rd " " 6th August 1900.

Syed Zille Hasnain, " " 3rd "

Surveyors.—Dhondu Vinayek, Vinayek Narayen, 16 Computers and 2 Native Artificers.

333. Lieutenant Crosthwait continued in charge of the party during the year.

TIDAL OPERATIONS.

334. The following is a complete list of stations at which tidal observations have been taken and where work is at present in progress. Permanent stations are shown in italics :—

	Station.	Automatic or Personal observations.	Date of commencement of observations.	Date of closing of observations.	Number of years of observations.	Remarks.
1	Suez	Automatic	1897	Still working.	3	
2	Perim	Ditto	1898	Ditto	2	
3	*Aden*	Ditto	1879	Ditto	20	
4	Muscat	Ditto	1893	1898	5	
5	Bushire	Ditto	1892	Still working	7	To be closed.
6	*Karáchi*	Ditto	1881	Ditto	19	
7	Hanstal	Ditto	1874	1875	1 }	Tide-tables not published.
8	Navánár	Ditto	1874	1875	1 }	
9	Okha Point	Ditto	1874	1875	1	
10	Porbandar	Personal	1893	1894	2	
10A	"	Automatic	1898	Still working.	2	With certain interruptions.
11	Port Albert Victor (Káthiáwádar)	Personal	1881	1882	1	
11A	" " (")	Automatic	1900	Still working	...	Started this year.
12	Bhávnagar	Ditto	1889	1894	5	
13	*Bombay* (Apollo Bandar)	Ditto	1878	Still working	22	
14	Bombay (Prince's Dock)	Ditto	1883	Ditto	12	Property of Port Trust.
15	Mormugão (Goa)	Ditto	1884	1889	5	
16	Kárwár	Ditto	1878	1883	5	
17	Beypore	Ditto	1878	1884	6	
18	Cochin	Ditto	1886	1892	6	
19	Tuticorin	Ditto	1888	1893	5	
20	Minicoy	Ditto	1891	1896	5	
21	Galle	Ditto	1884	1890	6	
22	Colombo	Ditto	1884	1890	6	
23	Trincomalee	Ditto	1890	1896	6	
24	Pámban Pass	Ditto	1878	1882	4	
25	Negapatam	Ditto	1881	1888	6	Year 1884-85 is excluded.
26	*Madras*	Ditto	1880 Re-started 1895	1890 Still working.	10 } 15 5 }	
27	Cocanada	Ditto	1886	1891	5	
28	Vizagapatam	Ditto	1879	1885	6	
29	False Point	Ditto	1881	1885	4	
30	Dublat (Saugor Island)	Ditto	1881	1886	5	
31	Diamond Harbour	Ditto	1881	1886	5	
32	*Kidderpore*	Ditto	1881	Still working.	19	
33	Chittagong	Ditto	1886	1891	5	
34	Akyab	Ditto	1887	1892	5	
35	Diamond Island	Ditto	1895	1899	5	Closed during the year.
36	Elephant Point	Ditto	1880 Re-started 1884	1881 1888	1 } 6 5 }	
37	*Rangoon*	Ditto	1880	Still working.	20	
38	Amherst	Ditto	1880	1886	6	
39	Moulmein	Ditto	1880	1886	6	
40	Mergui	Ditto	1889	1894	5	
41	Port Blair	Ditto	1880	Still working.	20	

The reduction of the records obtained at these stations and the publication of tide-tables containing the predicted times of high and low water at 39 ports have been carried out as usual.

335. During the year under review the station at Diamond Island was closed, and a new observatory at Port Albert Victor was opened. Bushire observatory will be closed and Bassein will be started during the coming year.

336. Besides the automatic registrations mentioned in the foregoing list, personal tidal observations to graduated staves were taken at Bhávnagar, Tuticorin, Chittagong, Akyab, and Moulmein, with the object of comparing actual times and heights of high and low water with predicted times and heights.

337. Special observations to tide-poles were also taken in order to check the accuracy of predictions at ports which had long been closed. Such observations were taken at Cochin, Negapatam, Cocanada, and Vizagapatam. The results show that for all practical purposes predictions are still accurate at these ports.

338. The Porbandar registrations were resumed in January last. Registrations at all other ports have been most satisfactory during the year.

The tidal observatories at work were all inspected during the year either by Lieutenant Crosthwait, Mr. Belcham or Mr. Shaw.

339. The office work connected with the reduction of the tidal observations for 12 stations has been successfully carried on during the year. There are no arrears.

The following tables give a summary of the percentage of errors in predicted times and heights of high and low water for the last 10 years:—

Percentage of Error in Periodical Times and Heights at Open Coast Stations from Automatic Observations.

Year.	Number of stations.	In time.		In height.			
		Within 15 minutes of Actuals.		Within 8 inches of Actuals.		Within $\frac{1}{10}$th of mean range at Springs.	
		H. W.	L. W.	H. W.	L. W.	H. W.	L. W.
1890	13	69	70	95	93	91	91
1891	10	74	73	94	87	98	97
1892	8	75	74	91	85	98	98
1893	9	73	68	93	98	96	95
1894	10	65	62	95	92	97	95
1895	9	68	65	98	97	94	94
1896	9	71	70	97	97	97	93
1897	8	71	75	96	97	97	97
1898	9	74	70	96	96	95	95
1899	9	74	66	95	95	93	92
Average of 10 years	9	71	69	95	94	96	95

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Percentage of Error in Periodical Times and Heights at Riverain Stations from Automatic Observations.

Year.	Number of stations.	In time.		In height.			
		Within 15 minutes of Actuals.		Within 8 inches of Actuals.		Within $\frac{1}{10}$th of mean range at Springs.	
		H. W.	L. W.	H. W.	L. W.	H. W.	L. W.
1890	3	53	55	64	63	90	86
1891	3	64	58	66	66	92	92
1892	2	61	60	72	65	94	95
1893	2	57	57	68	50	89	84
1894	2	56	55	66	42	88	80
1895	2	59	55	74	47	94	84
1896	2	56	55	63	42	87	74
1897	2	59	61	75	57	96	91
1898	2	53	59	71	61	90	91
1899	2	55	59	76	65	95	94
Average of 10 years	2	57	57	70	56	92	87

Spirit Levelling Operations.

340. Last field season the levelling detachment worked on the Eastern Bengal State Railway under Lieutenant Cowie. It was divided into two sections—one working with two levellers in the ordinary manner, and the other with a single leveller only. The latter section was especially formed at the request of the Railway authorities, who wished certain portions of the railway levelled and bench-marks fixed. The double levelling section worked from Calcutta to Dámukdia; the single levelling section over the following branch lines:—Manihári Ghât—Anchara Ghât, Katihár-Bársoi, Bársoi-Kishanganj, Bársoi-Párbatipur, and Porádaha-Faridpur.

The detachment left Dehra Dún on 4th November 1899, and returned to recess quarters on 26th April 1900.

341. Taking each class of levelling separately—

Double levelling.—The total rises and falls amounted to 1,890 feet, and the outturn of work to 124 miles, in the course of which the instrument was set up at 1898 stations. The heights of 11 embedded and 65 inscribed bench-marks were determined.

Single levelling.—Total rises and falls were 2,484 feet. The instrument was set up at 3,705 stations, and the outturn of work was 278 miles. Twenty-eight embedded and 161 inscribed bench-marks were connected. The heights of two Great Trigonometrical stations were also determined.

342. During next field season double levelling will be resumed on the Eastern Bengal State Railway and carried towards the Sonákhoda base-line, which has already been connected with mean sea-level by another route.

Major Burrard, Superintendent, Trigonometrical Surveys, inspected the party on the 23rd and 24th July 1900.*

* Lieutenant Crosthwait reports favourably of Messrs. Belcham, Connor and Shaw and Surveyor Dhondu Vinayek of the Tidal Section, and Mr. Barker and Munshi Syed Zille Hasnain employed with the levelling detachment. The staff of computers and mechanics is also well reported on.

TABULAR STATEMENTS.

LIBRARY OF THE BOMBAY BRANCH OF THE ROYAL ASIATIC SOCIETY

Summary of the Outturn of work of the

Scale of Survey.	Number of Party.	Locale of Field Operations.	Triangulation. Instrument used. Diameter in inches.	Area in square miles.	Square miles to each point trigonometrically fixed.	Square miles to each height	1st class. Stations fixed.	1st class. Triangular error in seconds.	1st class. Error per mile in feet.	Secondary. Stations fixed.	Secondary. Triangular error in seconds.	Secondary. Error per mile in feet.	Tertiary. Intersected points.	Tertiary. Error per mile in feet.	Spirit-levelling Operations. Miles levelled over.	Permanent bench-marks fixed.	Tidal observations
Inches to a mile.																	
105·6	18	Simla Municipality	5 & 6	...	...	...	...	...	...	...	...	...	...	...	...	...	...
132 & 64	7	Mandalay Cantonment	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
64	7	Toungoo Town	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
16	Provincial Surveys.	N.-W. Provinces, Azamgarh	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		" Gonda	5	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		" Farrukhabad	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		" Pilibhít	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		" Bísalpur	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		" Mainpuri	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		" Etáwah	10	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		" Etah	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		" Aligarh	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		" Kheri	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		" Jálaun	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	Bengal Surveys. 4	Bengal, Sonthal Parganas	15	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		" Monghyr	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		" Sháhabad	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		" Darbhanga	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		N.-W. Provinces, Mauza Ballia	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Bengal, Noákháli	20	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		" Darbhanga Municipality	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	7	Upper Burma, Lower Chindwin	...	5 & 6	...	...	...	...	...	...	...	...	...	...	...	...	...
		" Katha	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Lower Burma, Pegu	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	10	Maymyo Town	25	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	17	Bombay Forests	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	Detachment.	Punjab, Kohát	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	Detachment.	Central Provinces, Chhindwára Jágirs	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		" Hoshangabad Jágirs	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		" Nimár Raiyatwári	30	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		" Raipur Zamindári	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		" Bilaspur boundary dispute	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	Detachment.	Assam, Goálpára	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		" Sylhet	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		TOTAL	35	...	...	...	...	...	...	...	...	...	...	...	...	...	...
12	15	Attock		6	31	0·1	0·1	...	...	...	28	10·5	0·2	707	0·3	...	...
		Secunderabad and Bolarum Cantonments		6	22	0·2	0·2	...	...	...	7	10·0	0·4	124	0·4	...	...
		TOTAL		...	53	...	...	...	...	...	...	...	...	...	...	...	...	...
8	17	Bombay Forests		6 & 7	227	1·4	1·4	...	...	...	162	9	0·3	873	0·4	...	...
		Carried over	40	...	280	...	...	...	...	...	...	...	...	...	...	...	...

Field Parties during the year 1899-1900.

Traversing.				Detail Survey.					Record Writing.			Remarks.
Area in square miles.	Number of stations at which the theodolite was set up.	Angular error per station in seconds.	Linear error per *mille*.	Area in square miles.	Plane-table fixings per square mile.	Linear miles of test lines.	Villages.	Average size of fields in acres.	Area in square miles.	Villages.	Fields.	
...	1,825	3·4	0·49	...	...	...	...	...	...	...	...	
5	1,571	1·2	0·10	5	...	19	3	0·33	...	...	4,293	
2	841	1·2	0·06	2	...	12	1	0·40	...	...	4,086	
...	...	...	...	552	...		1,382	...	660	1,602	15,71,253	
5	375	7,196	9·0	4·50	640	...		618	...	639	617	10,69,122	
...	...	...	...	...	443	...		454	...	301	368	2,14,797	
...	...	...	...	...	442	...		311	...	455	328	1,78,752	
...	...	...	...	...	159	...	18,003	160	...	199	211	1,48,893	
...	366	4,533	10·0	4·50	581 (*a*)	...		404	...	280	300	2,08,572	(*a*) Includes 180 square miles surveyed in very large villages, on which the entire survey has not been completed.
10	363	5,424	11·6	0·63	460	...		585	...	312	500	2,29,827	
...	457	7,881	10·0	1·89	401	...		427	...	187	295	1,39,309	
...	335	5,211	17·0	4·35	384	...		152	...	73	40	24,805	
...	49	611	9·0	...	...	...	...	...	...	...	...	...	
...	699	11,617	7·4	0·73	...	...	...	...	...	...	...	...	
15	759	25,668	4·6	0·16	...	...	...	...	...	...	...	...	
...	542	15,906	1·9	0·29	...	...	...	...	...	...	...	...	
...	9	1,797	...	...	...	...	...	...	...	...	...	...	
...	...	...	...	...	917	...	5,173	727	0·37	731	599	12,28,595	
...	8	116	...	...	7	...	45	1	1·41	7	1	3,084	
20	62	608	2·7	0·65	...	...	...	...	...	...	...	...	
...	...	...	...	...	...	...	...	...	0·07	4	...	30,326	
...	816	15,980	3·8	0·50	829	...	2,318	437	1·44	...	...	...	
...	...	...	...	...	15	...	45	8	1·11	...	...	...	
...	...	...	...	...	183	...	509	93	0·42	...	...	...	
25	...	...	...	...	18	...	...	...	...	...	...	...	
...	...	...	...	...	55	262	189	...	...	...	...	...	
...	2,530	4,387	2·0	0·45	...	...	...	...	...	...	...	...	
...	635	6,891	3·0	1·10	...	...	...	...	...	...	...	...	
...	47	370	3·0	0·50	...	...	...	...	...	...	...	...	
30	203	2,700	3·0	0·60	...	...	...	...	...	...	...	...	
...	91	2,098	4·0	0·70	...	...	...	...	...	...	...	...	
...	2	110	2·0	1·20	...	...	...	...	...	...	...	...	
...	48	1,519	4·0	0·10	...	...	...	...	...	...	...	...	
...	15	2,509	2·0	0·10	...	...	...	...	...	...	...	...	
35	8,442	...	...	...	6,086	...	...	...	...	3,848	...	...	
...	...	...	...	...	12	683	27	...	...	...	...	...	
...	...	211	3·0	0·03	34	244	54	...	...	...	...	...	
...	...	...	...	...	46	...	...	...	...	...	...	...	
...	...	...	...	...	236	257	190 and *in situ*.	...	...	...	...	...	
40	...	...	...	...	6,375	...	...	...	...	3,848	...	...	

Summary of the Outturn of work of the

Scale of Survey.	Number of Party.	Locale of Field Operations.	Triangulation: Instrument used. Diameter in inches.	Triangulation: Area in square miles.	Triangulation: Square miles to each point trigonometrically fixed.	Triangulation: Square miles to each height.	1st class: Stations fixed.	1st class: Triangular error in seconds.	1st class: Error per mile in feet.	Secondary: Stations fixed.	Secondary: Triangular error in seconds.	Secondary: Error per mile in feet.	Tertiary: Intersected points.	Tertiary: Error per mile in feet.	Spirit-levelling Operations: Miles levelled over.	Permanent bench-marks connected.	Trigonometrical Stations connected with.
Inches to a mile.		Brought forward	...	280	...	...	...	...	...	...	...	...	...	...	...	...	...
4	3	Yenangyat Oil Field	... 6	537	0·3	0·2	...	...	...	134	10·4	0·5	330	0·9	...	...	...
	9 & 19	Madras Forests, Kurnool	... 6 & 7	1,429	1·1	1·2	...	...	...	243	19	0·8	911	1·3	...	...	...
		,, Coimbatore	...														
		,, Cuddapah	... 45														
		,, South Kánara	...														
	12	Sind	... 8 & 6	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	17	Bombay Forests	... 5, 6 & 7	315	4·1	4·1	...	...	...	...	...	...	...	...	...	...	...
	18	Himalayas, Forests	... ...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Burma Forests	50 6	1,170	5·8	5·8	...	...	...	15	11	1·4	...	...	...	...	...
		Dehra Dún	... 5	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Kheri (Nepál-Kheri boundary)	... ...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Central Provinces, Saugor	... ...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		,, Hoshangabad, Betúl, Nimár	... 7 & 6	(*b*) 475	5·3	5·3	...	...	...	13	14	0·6	56	0·7	...	...	...
		,, Mandla	55 ...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		,, Seoni	... 5	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		,, Biláspur	... 6	22	1·2	1·2	...	...	...	4	6	1·5	11	1·6	...	...	...
		,, Sambalpur	... 5	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Bengal, Singhbhum	... 7	150	21·4	12·5	...	...	...	1	2	0·7	1	...	...	...	...
		Punjab, Chamba State	60 7	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		,, Montgomery	... 7 & 5	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		,, Hazára	... 10 & 7	340	...	...	...	...	...	...	...	...	...	...	...	...	...
		Total	... ...	4,438	...	...	...	...	...	...	...	...	...	...	...	...	...
2	3	Lower Burma	... ...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	12	Sind	65 7 & 5	901	16·5	16·5	...	...	...	24	5·2	0·2	58	0·6	...	...	...
	15	Kashmir	... ...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	18	Himalayas	... ...	693	...	...	...	...	...	...	...	...	...	...	...	...	...
	Det.	Punjab, Sirmúr State Forests	... ...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Assam, Brahmaputra River	... ...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Total	70 ...	1,594	...	...	...	...	...	...	...	...	...	...	...	...	...
1	3	Lower Burma	... 6	3,220	7·2	8·1	...	...	...	76	7·5	0·3	414	0·6	...	...	...
	10	Upper Burma	... 6	6,550	10·5	11·2	...	...	...	71	4·8	0·1	543	0·6	...	...	...
	11	Upper Burma	... 6	3,070	5	5·1	...	...	...	61	9·5	0·2	545	0·8	...	...	...
	14	Lushai Hills	... 6	787	3·6	3·6	...	...	...	12	9·4	0·5	122	0·5	...	...	...
	15	Sind	75 6	930	23·8	23·8	...	...	...	29	5	0·3	53	0·4	...	...	...
		Punjab, Kohát	... ...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	18	Punjab, Himalayas	... ...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	21 Forest Branch.	Upper Burma	... 6	(*g*) 3,191	6·3	6·7	...	...	...	17	10·7	0·2	373	0·8	...	...	...
		Punjab, Chamba	... ...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Total	80 ...	17,798	...	...	...	...	...	...	...	...	...	...	...	...	...
½	14	North-East Frontier	... ...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	15	Kashmir	... ...	1,000	...	...	...	...	...	11	...	...	20	...	...	...	...
		Total	... ...	1,000	...	...	...	...	...	...	...	...	...	...	...	...	...
¼ & ⅛	14	Lushai Hills	... ...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	15	North-West Frontier	85 6	16,000	84	...	...	...	...	191	27	0·4	...	...	...	...	...
	21	North-East Frontier	... ...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Total	... ...	16,000	...	...	...	...	...	...	...	...	...	...	...	...	...
	25	India	... ...	...	...	...	...	...	...	...	...	...	...	...	(*h*) 124·5 (*i*) 278·3	76 189	... 2
		GRAND TOTAL	89 ...	41,110	...	...	...	...	...	...	...	...	...	...	...	...	...

Field Parties during the year 1899-1900—contd.

Traversing.				Detail Survey.					Record Writing.			Remarks.
Area in square miles.	Number of stations at which the theodolite was set up.	Angular error per station in seconds.	Linear error per *mille*.	Area in square miles.	Plane-table fixings per square mile.	Linear miles of test lines.	Villages.	Average size of fields.	Area in square miles.	Villages.	Fields.	
...	...	...	...	6,375	...	...	...	...	3,848	...	...	
...	...	...	...	...	...	...	...	...	...	...	...	
...	38	3·0	0·30	413	68	34	...	...	...	...	...	
...	524	5·0	0·40	727	37	30	...	...	...	...	...	
45	1,505	7·5	1·10	384	41	24	...	...	...	...	...	
...	1,894	3·0	1·50	...	...	...	...	...	...	...	...	
... 425	1,540	1·1	1·60	425	23	347	...	...	...	...	...	
... ...	1,775	0·1	0·70	379	96	45 and *in situ*.	...	...	...	...	...	
... ...	...	...	...	108	37	...	...	...	...	...	...	
50 ...	17,999	5·1	2·90	708	...	231	...	...	...	...	...	
... ...	91	8·0	2·50	2	100	...	...	...	...	...	...	
... ...	114	4·0	1·00	...	...	...	...	...	...	...	...	
... ...	...	...	...	72	264	21	...	...	...	...	...	
... ...	775	4·0	2·40	245	213	79	...	...	...	...	...	(*b*) Includes 65 square miles of triangulation not computed. Traversing 4 linear miles not closed.
55 ...	...	...	...	443	235	72 and *in situ*.	...	...	...	...	...	
... ...	295	(*c*)	(*c*)	139	219	27	...	...	...	...	...	(*c*) Traversing not computed.
... ...	248	15·0	2·80	320	108	*in situ*.	...	...	...	...	...	(*d*) Traversing 3·3 linear miles not closed.
... ...	148(*d*)	3·0	0·08	204	211	54	...	...	...	...	...	(*e*) Traversing 1·3 linear miles not closed.
... ...	...	...	...	185	58	12 and *in situ*.	...	...	...	...	...	(*f*) Revision of cadastral survey.
60 ...	504(*e*)	7·0	5·50	31	18	*in situ*.	...	...	...	...	...	(*g*) Triangulation includes 1,575 square miles of revision work.
... ...	1,746	6·0	1·30	72	33	...	...	...	...	...	...	(*h*) Double levelling.
... ...	...	...	...	...	...	...	...	...	...	...	...	(*i*) Single levelling.
... ...	...	...	...	4,857	...	...	...	...	...	...	...	
... ...	...	...	...	310	69	59	...	...	...	...	...	
65 2,250	10,614	0·5	1·40	2,383	20	*in situ*.	...	...	...	...	...	
... ...	...	...	...	331	...	...	...	...	...	...	...	
... ...	...	...	...	655	34	50 and *in situ*.	...	...	...	...	...	
... ...	...	...	...	309	...	...	...	...	...	...	...	
... 200	1,822	4·0	0·06	171	...	11	...	...	...	...	...	
70 ...	...	...	...	4,159	...	...	...	...	...	...	...	
... ...	...	...	...	1,508	6·4	114	...	...	...	...	...	
... ...	...	...	...	{ 2,000 / 1,350 (*f*) }	5	*in situ*.	...	...	...	...	...	
... ...	...	...	...	2,141	6·6	87	...	...	...	...	...	
... ...	...	...	...	759	2·3	*in situ*.	...	...	...	...	...	
75 ...	...	...	...	...	...	...	...	...	...	...	...	
... ...	...	...	...	87	...	...	...	...	...	...	...	
... ...	...	...	...	168	2	...	...	...	...	...	...	
... ...	...	...	...	1,701	4·7	*in situ*.	...	...	...	...	...	
... ...	...	...	...	249	17	*in situ*.	...	...	...	...	...	
80 ...	...	...	...	9,963	...	...	...	...	...	...	...	
... ...	...	...	...	808	...	...	...	...	...	...	...	
... ...	...	...	...	3,256	0·4	*in situ*.	...	...	...	...	...	
... ...	...	...	...	4,064	...	...	...	...	...	...	...	
... ...	...	...	...	344	0·1	...	...	...	...	...	...	
85 ...	...	...	...	27,515	...	...	...	...	...	...	...	
... ...	...	...	...	92,400	...	...	...	...	...	...	...	
... ...	...	...	...	120,259	...	...	...	...	...	...	...	
... ...	...	...	...	...	...	...	...	...	...	...	...	
89 ...	...	...	...	149,677	...	...	...	...	3,848	...	...	

Statement showing the cost-rates of work executed by the

Number of Party.	Nature and *locale* of Field Operations.	Cost-rate per square mile.									
		Triangulation.	Traversing.	Detail survey and preparation of maps on scales of							
				½″	1″	2″	4″	6″	8″	12″	16″
	Topographical Surveys.	₹	₹	₹	₹	₹	₹	₹	₹	₹	₹
3	Lower Burma	4·8	...	...	25·5	94·2	...	...	...	...	...
3	Yenangyat Oil Field	7·8	...	...	...	...	98·3	...	...	...	...
10	Upper Burma	3·9	...	...	20·3	...	...	...	...	...	842·7
11	Upper Burma	11·1	...	...	20·4	...	...	...	...	...	...
12	Sind	...	2″=14·3(*c*) 4″=19·3	...	...	10·0	30·6	...	...	...	5
14	Lushai Hills	42·5	...	...	56·4	...	...	...	...	...	...
15	Attock	67·0	...	...	...	...	...	...	...	730	...
15	Secunderabad		...	...	...	...	...	...	...	572	...
15	Ráwalpindi	...	...	...	...	...	...	53	...	...	...
15	Sind	4·0	...	...	7·5	...	...	...	...	...	10
15	Kashmir	1·0	...	5·5	...	...	...	...	...	...	...
18	Himalaya	18·5	...	...	45·6	49·3	60·2	...	...	...	...
21	Upper Burma	16″=17·4 1″= 9·9	...	...	17·8	...	...	...	...	...	...
	Forest Surveys.										
9 & 19	Madras	8·4 (*g*)	...	...	...	...	58·1	...	...	...	...
17	Bombay	4″= 5·8 8″=17·6	...	...	...	...	64·2	...	139·5	...	134·1	15
18	Himalaya	...	...	...	...	45·6	60·2	...	...	...	...
Forest Branch.	Burma	23·4	...	...	...	...	97·5	...	...	...	...
Forest Branch.	Central Provinces	5·1	...	...	...	...	39·1	...	...	...	...
Forest Branch.	Singhbhum	20·6	...	...	...	...	80·6	...	...	...	...
Forest Branch.	Punjab, Chamba	7·1 (*i*)	...	...	12·8 (*i*)	...	52·1 (*i*)	...	...	...	20
Forest Branch.	Do., Hazára	9·0	...	...	...	...	...	...	...	...	...
	Cadastral Surveys.										
Provincial Surveys.	N.-W. Provinces	...	26·3	...	...	...	...	...	...	67·5	...
Bengal Surveys 4 & and Detachments.	N. Bihar	...	51·7	...	...	...	...	...	...	72·3	...
Bengal Surveys 4 & and Detachments.	Sonthal Parganas	...	43·6	...	...	...	...	...	...	...	...
7	Pegu, Lower Burma	...	...	...	...	...	...	...	...	234·1	25
7	Lower Chindwin, Upper Burma	...	59·1	...	...	...	...	...	...	100·0	...
	Traverse Surveys.										
Detachment	Kohát, Punjab	...	17·7	...	...	...	...	...	...	...	...
Detachment	Central Provinces	...	25·5	...	...	...	...	...	...	...	...
Detachment.	Brahmaputra River Survey	...	13·9	...	...	10·3	...	...	...	...	...
Detachment.	Lakhimpur, Assam	...	47·3	...	...	...	...	...	...	...	30
Detachment.	Goálpára „	...	25·7	...	...	...	...	...	...	...	...
Detachment.	Sylhet „	...	63·1	...	...	...	...	...	...	...	...
Detachment.	Do., disforested area, Assam	...	120·3	...	...	...	...	...	...	...	...

several Field Parties during the year 1899-1900.

	Cost-rate per acre.	Cost-rate per square mile.			Total cost, inclusive of charges for instruments to Provincial Governments.	Remarks.
	Cadastral survey, including traversing, detail survey and mapping.	Stone embedding.	Records (*khánápuri*).	Completion of vernacular records, assessment statistics, etc.,		
	Annas.	*R*	*R*	*R*	*R*	
...	...	...	...	...	87,597	(*a*) Includes R15,167 expended on Maymyo Town survey on 16-inch scale.
...	...	...	...	...	20,042	(*b*) Exclusive of R7,057 *on account* of Drawing Office.
...	...	...	...	...	93,963 (*a*)	(*c*) Includes triangulation.
...	...	...	...	...	82,999 (*b*)	(*d*) Includes R1,452 expended on the survey of Aijal on 24-inch scale; R285 on 4-inch survey and R9,160 on reconnaissance survey.
5	...	...	...	...	90,086	(*e*) Includes R:0,374 share of superintendence debitable to Drawing Section and R3,571 for arrears of mapping.
...	...	...	...	...	80,981 (*d*)	(*f*) Includes R19,068 for arrears of mapping; R2,134 for instruction of soldier-surveyors and pupils; R4,027 for Simla survey and R334 for survey of Viceregal Lodge, Simla.
...	...	...	...	...		(*g*) Includes traversing.
...	...	...	...	...	} 1,20,803 (*e*)	(*h*) Includes R2,836 for share of instruments.
10	...	...	...	...		(*i*) Final cost-rates for the district, not for the season.
...	...	...	...	...		(*j*) Includes R851 expended on Nepál-Bhágalpur boundary survey; R696 on revision of Orissa traversing and 15,607 on Khurda *badars*.
...	...	...	...	...	80,418 (*f*)	(*k*) Includes R3,145 expended on survey of Toungoo City; R213 on detail survey in Toungoo; R2,003 on 2-inch mapping of district Toungoo and R16,143 for printing Rangoon Town maps.
...	...	...	...	...	1,05,210	(*l*) Includes R2,481 expended on survey of Mandalay Cantonments; R9,505 on revision survey in district Katha; R25,080 for completing traverse and cadastral records of districts surveyed in 1892-99.
						(*m*) Includes R995 for mapping section.
						(*n*) Includes R1,462 for standard mapping and R12,154 for maintenance of records.
...	...	...	...	...	1,09,180 (*g*)	
15	...	...	...	...	72,578	
...	...	...	...	...	...	
...	...	...	...	...	1,62,855	
...	...	...	...	...	76,501	
...	...	...	...	...	18,413	
20	...	...	...	...	18,128	
...	...	...	...	...	3,061	
...	...	2·4	...	...	3,12,805	
...	3·04	3·0	69·5	70·8	} 3,50,915 (*j*)	
...	...	2·3	...	...		
25	5·87	...	...	...	64,469 (*k*)	
...	2·50	9·7	...	...	1,76,343 (*l*)	
...	...	...	...	...	44,620	
...	...	1·0	...	...	25,968 (*m*)	
...	...	...	...	...		
30	...	...	...	...		
...	...	...	...	...	} 29,505 (*n*)	
...	...	...	...	...		
33	...	...	...	...		

PART III.

THE OPERATIONS AT THE HEAD-QUARTERS OFFICES.

343. These offices comprise—

(1) The Head-Quarters Offices at Calcutta.
(2) The Trigonometrical Branch Office at Dehra Dún.
(3) The North-Western Frontier Drawing Office.
(4) The Forest Survey Branch Office at Dehra Dún.

A description of the work carried on in each office is given below :—

I.—HEAD-QUARTERS OFFICES, CALCUTTA.

SUPERINTENDENCE, CORRESPONDENCE AND ACCOUNTS.

Superintendence.

Colonel St. G. C. Gore, R.E., Surveyor-General of India.
Colonel J. R. Hobday, I. S. C., Deputy Surveyor-General in charge Revenue Branch (on privilege leave from 22nd February to 22nd May 1900).
Major F. B. Longe, R. E., Officiating Deputy Surveyor-General from 22nd February to 22nd May 1900 and Assistant Surveyor-General from 6th November 1899 to 9th March and again from 23rd May 1900, up to the close of the year.
Major J. M. Fleming, I.S.C., Officiating Assistant Surveyor-General from 10th March to 22nd May 1900 and on duty at Head-Quarters up to 28th June 1900, and thereafter in charge of Drawing and Engraving Offices.
Captain P. J. Gordon, I.S.C., Officiating Assistant Surveyor-General up to 5th November 1899.
Mr. T. W. Babonau, Registrar, on leave up to 22nd January 1900, when he retired.
„ T. A. Milne, Registrar, from 23rd January 1900.

Correspondence.

Mr. G. C. Walker, Head Clerk,
„ E. H. Webb, „ from 16th January to 20th July 1900,
Babu Chuni Lal Dey, Head Clerk,
„ Kalipodo Banerji, Clerk, up to 26th October 1899,
„ Beni Madhab Banerji, Clerk,
„ Durga Narain Ghosh „
„ Gopal Chunder Dass „
„ Kali Kristo Chunder „
„ Kanti Chunder Sen „
and thirteen others.

Accounts.

Mr. C. O. Gray, Head Assistant,
Babu Raj Krishna Mukerji, Clerk,
„ Hemnath Dutt „
„ Norendra Nath Mukerji „
and seven others.

344. The general direction of these offices remained in the hands of Colonel Gore throughout the year, and the Revenue Branch section under Colonel Hobday, except for the period from 22nd February to 22nd May 1900, while he was on privilege leave, when Major Longe officiated for him. The General and Topographical Branch sections were under Captain Gordon up to 5th November 1899, when he was relieved by Major Longe who, with the exception of the period for which Major Fleming officiated for him, during Colonel Hobday's absence on leave, *viz.*, 10th March to 22nd May 1900, retained charge until the end of the year.

345. The amalgamation of the clerical establishments of the several head-quarters offices in Calcutta and Dehra in one list, for the purpose of promotion, was sanctioned by the Government of India during the year and was brought into effect from the 7th December 1899. The system has not had a long enough trial to say definitely whether it is or is not a success but though it has relieved the congestion in certain sections it has certainly developed many unexpected drawbacks.

There has been no change in the system of carrying on the work of this office, which is of a purely routine description.

The Assistant Surveyor-General reports as follows :—

Mr. Milne as Registrar has satisfactorily carried out his various duties and Mr. Gray and Babu Chuni Lal Dey have done very good work in charge of their sections. The following clerks are also worthy of special mention :—Beni Madhab Banerji, Raj Krishna Mukerji, Norendranath Mukerji, S. C. Biswas, R. J. Mendieta and Bepin Madhab Banerji.

DRAWING OFFICE.

346. The Drawing office was under the superintendence of Mr. Spring till the 29th June, when he proceeded on leave and was relieved by Major Fleming, who continued in charge during the remainder of the year.

SECTION I.—GEOGRAPHICAL DRAWING AND COMPILATION.

347. This section deals with the compilation, correction and publication of maps of all kinds. The following sheets of the North-Eastern Frontier series were dealt with: No. 22 (6th edition) on the scale of 1 inch=8 miles was published; Nos. 23 N. E., S.E.; 30 N.E., S.E., S.W.; 31 N. E., S.E., N.W., S.W.; 37 S.W. and 38 S.W. on the scale of 1 inch=4 miles are under publication; sheets 15 S.W. and 23 S.W. (8th edition) also on the scale of 1 inch=4 miles were brought up to date and sheet 23 (2nd edition) on the scale of 1 inch=8 miles is now in hand. Of the South-Eastern Frontier series sheets 1 N.E. (7th edition), 1 N.W., (5th edition), 2 N.E (7th edition), all on the scale of 1 inch=4 miles were completed and published, and sheets 1 S. E. (5th edition), 2 S.E. (5th edition), 5 S.W. (6th edition) on the same scale were brought up to date. Sheet No. 2 (2nd edition) on the $\frac{1}{8}$-inch scale had the railways brought up to date and published. Sheets 3 (2nd edition) and 7 (2nd edition) on the $\frac{1}{8}$-inch scale were also brought up to date and published; sheet No. 3 S.E. on the $\frac{1}{4}$-inch scale, sheets 4 (2nd edition), 5, 6 (2nd edition) on the $\frac{1}{8}$-inch scale, are in progress; and sheet 8 (2nd edition) also on the $\frac{1}{8}$-inch scale and sheets 12 N.E., 12 S.E. and 20 N.W. on the $\frac{1}{4}$-inch scale are now under publication.

Personnel.

Mr. W. Stotesbury, Chief Draftsman, up to 2nd July 1900.

Mr. E. P. S. Hill, Officiating Chief Draftsman, from 3rd July 1900.

Extra Assistant Superintendents and Sub-Assistant Superintendents on duty and European Draftsmen.

Mr. A. G. Wyatt, Extra Assistant Superintendent, 2nd grade, up to 25th February 1900.

Mr. T. H. Rendell, Extra Assistant Superintendent, 2nd grade.

Mr. J. Bond, Extra Assistant Superintendent, 2nd grade, from 4th November 1899 to 26th September 1900.

Mr. R. C. D. Ewing, Extra Assistant Superintendent, 2nd grade, up to 7th November.

Mr. G. Campbell, Extra Assistant Superintendent, 4th grade.

Mr. J. Murphy, Extra Assistant Superintendent, 5th grade.

Mr. E. C. J. Bond, Sub-Assistant Superintendent, 2nd grade, from 27th April to 27th August 1900.

Mr. A. J. Musgrove, Draftsman.
" A. S. Bateman "
" C. L. Green "
" E. W. Stark "
" A. S. Nelson "
" J. Kitchen "
" E. B. West "

Native Draftsmen.

Babu Purna Chandar Sen,
" Sarat Chandar Chatterjee,
" Narendra Nath Mukerjee,
" Subodh Chandar Sarkar,
" Sarat Chandar Kumar, and 28 others.

348. The standard sheets on the scale of 1 inch=1 mile dealt with were:—Assam sheet 162 published, and 163 under publication; of Bengal 5 sheets were added to and published. Bombay sheet 247 is under publication; 18 sheets of the Burma-China Boundary Commission were published; and of Upper Burma sheets 242 (2nd edition), 285, 293 (2nd edition), 294 (2nd edition), 331, 379, 380, 382, 383, 384, 385, 386, 387 and 439 were published; whilst sheets Nos. 289, 290, 291, 292, 297, 335, 336, 337, 338, 377, 378, 381 and 388 are under publication; and sheets 240, 243, and 244 are now going through 2nd edition. Of Lower Burma sheet 255 was brought up to date and published, whilst 13 sheets of the Forest Survey on the 4-inch scale were also published. Of the Central India and Rájputána series 29 sheets were brought up to date and published and 3 sheets had additions made to them. Of the Central Provinces 2 sheets were completed and published and 4 more are being completed to margins. One sheet of the Hyderabad series was also brought up to date and 23 sheets of the Lower Provinces were similarly dealt with and published. Of the Punjab 8 sheets were corrected and published, and one is under publication. Of the Madras Forest survey on the 4-inch scale 21 sheets were completed and published and 99 sheets are now passing through the proof stage and will be published shortly. Sheets 107, 138, 139, and 320 of Madras on the 1-inch scale had additions made to them and were published.

349. One section of this office has continued to deal with the sheets of the Atlas of India, and added to or corrected the railways, roads, boundaries, etc., in 30 sheets; in 67 sheets additions were made to names and outlining, and 13 were brush shaded for engraving of hills.

350. The General maps dealt with were the 32-mile map of Burma and adjacent countries, with hills, which had railways added; India 32-mile scale, showing railways, was completed, but owing to the heavy additions made to it in

proof, the original had to be gone over again and rephotographed and the map is once more in the proof stage and will be published early next year. The route map of the Western Himalayas which was put in hand last year, has had heavy additions made to it, and been thoroughly revised and it will be in the hands of the engravers shortly. The several maps of India on scales of 1 inch =32 miles, 48 miles, 64 miles, 80 miles and 128 miles have had the railways etc., brought up to date and a considerable amount of new compilation has been carried out on sheet No. 4 of the first.

A new map of India on the scale of 1 inch=64 miles has been projected on copper and the material for it is under compilation. A new 32-mile map of India has also just been put in hand, and new stones are being prepared from transfers from the engraved plates of the skeleton map. The details on these plates will be brought up to date and it is intended to publish the new map with hills in brown. The stones of the old 32-mile map are now so worn down that a new set is an imperative necessity. This most useful map is being pushed on rapidly, and it is hoped that before very long a 4th edition will be ready for issue.

A new map of India and adjacent countries on the universal atlas scale of $\frac{1}{1,000,000}$ has also been put in hand, but little progress has been made with it. The first edition is to be a lithographic one, the sheets being drawn on the scale of 1 inch=12 miles and reduced by photography to the required scale. As the lithographed sheets are completed, the engraving of the map on copper will be taken up.

351. Of Provincial maps on the scale of 1 inch=16 miles, 28 sheets were brought up to date and 8 published; 6 sheets on the scale of 1 inch=32 miles were also revised and reprinted; and in that of Bombay on the scale of 1 inch =16 miles the hills were brush shaded for engraving. Of District maps on the scale of 1 inch=4 miles, 15 sheets were revised and 7 reprinted; in that of Darjeeling the hills were brush shaded and the map sent for engraving. Eight Administration maps on various scales were also brought up to date and 6 published and 27 District maps on the 8-mile scale, 1 on 20 miles and 2 on 16 miles were also corrected, added to and brought up to date; 18 of these were published, and in 8 of them the hills were brush shaded for engraving. Fifteen Cantonment maps were corrected and brought up to date, and 4 were reprinted, Of the maps of Calcutta on the scale of 1 inch=50 feet, 9 sheets were revised by actual survey on the ground; the zinc plates corrected and 2nd editions published. Of the Index maps required for the illustration of this report 12 were brought up to date and published; 5 were newly prepared and published, and a useful set of Provincial index maps showing scales and seasons of survey and publication were also put in hand; those of Assam, Bengal, North-Western Provinces and Oudh being completed and published; while those of the Central Provinces and Punjab are in progress. A similar map of Burma showing scales of surveys has also been prepared and will shortly be published and one showing the forest surveys in the Punjab was also completed and published. The postal map of Bengal and Bihar, is now in proof and will be published shortly and a large number of other maps have also been prepared for other departments.

352. The military map of India on the scale of 1 inch=32 miles has been completed, and published during the year. A map on the scale of 1 inch=16 miles for reduction to half-scale prepared for the Military Department to illustrate the new Route Book of the Bengal Command is also in proof, and will, it is hoped, be published shortly. A map showing Dispensaries and their classifications has also been completed and is nearly ready for publication; a map of Nepál for the Resident showing centres of Gurkha recruitment; maps of Assam to illustrate police report and one showing emigration routes and depôts have been completed and published for the Assam Government. Three manœuvre maps of country round Agra and Goona on the 4-mile scale and Ráwalpindi on the 1-inch scale were also prepared and published. A map of China and another of the Yangtze river valley in two colours were published for the Quarter Master General's department, the work having been carried out at very short notice. A series of Census maps has also been put in hand for the Census Commissioner. A map to illustrate the Botany of the drainage area of the Ganges and Jumna is also in hand; and a map of the North-east Frontier of Assam comprising country inhabited by Abars and Mishmis on the $\frac{1}{4}$-inch scale was also published.

353. These increasing large and constant extra-departmental demands for maps of all sorts and kinds entail the withdrawal of a large part of the staff from their legitimate work, which thus falls into arrears, and steps will have to be taken to make special arrangements for meeting them in future. They are almost invariably urgent and consequently departmental work has to be put aside and suffers accordingly. This is one of the chief causes of delay in the publication of the departmental standard sheets which continues very much in arrears.

354. There were 1,453 maps coloured for departmental purposes and 4,071 for other departments, and the usual large amount of professional data was extracted from records and supplied to various officers.

The clerical work of the section has been very heavy, 3,500 letters having been received and replied to. The supervising staff of this section is now scarcely equal to the work which increases every year. The Chief Draftsman's time is so much occupied with correspondence, references, etc., that it is impossible for him to devote much time to the supervision of the actual drawing.

355. The revision of the map catalogues which are much out of date has been taken in hand. Those of Bengal and the Punjab are now at press, and that of the North-Western Provinces will shortly follow, but such work can only be taken in hand when some Provincial officer happens to be available.

The examining section has been supervised by Messrs. Wyatt and Rendell, who have been assisted by Mr. Campbell when not required for other jobs and for a short time by Mr. Bond (Jr). The work in this section would appear to be steadily increasing until it is now quite double what it was 10 years ago, when its staff was constituted, as may be seen from the return below:—*

YEAR.	1890.	1891.	1892.	1893.	1894.	1895.	1896.	1897.	1898.	1899.
No. of Sheets examined . .	1,068	1,250	1,457	2,102	2,092	2,062	2,162	2,314	2,327	2,318

SECTION II.—REVENUE.

356. This section is employed in bringing up to date and republishing old maps, examining the field books and computations received from the field parties of the Revenue branch and in preparing index maps showing the outturn of the Revenue parties; in tracing maps, furnishing plans and data to applicants and in examining the colouring of maps for issue.

357. Sheets 108 and 134 of Peshâwar district referred to at paragraph 349 of last year's report have been completed in drawing and are now under examination. There will be some delay in their publication, as the district boundary obtained from the congregated *patwâri* maps, cannot be reconciled with the features along which it is apparently intended to run and which have been taken from the departmental maps. Maps of 7 cities or cantonments on various scales were dealt with and 154 sheets have been published of the Rangoon Town map on the scale of 1 inch = 100 feet. Two wall maps of Rangoon Town on scales of 1 inch = 300 feet, and 1 inch = 1,000 feet, have been corrected and sent for reproduction, and are now passing through the press. The map of Bareilly Cantonment on the scale of 12 inches = 1 mile for reduction to half scale on 21 sheets has been completed in drawing and awaits examination for press. The

Personnel.

Mr. E. P. S. Hill, Head Draftsman, to 2nd July 1900.
Mr. W. H. Penrose, Offg. Head Draftsman, from 3rd July.

Extra and Sub-Assistant Superintendents.

Mr. J. Murphy, Extra Assistant Superintendent, 5th grade, from 1st October 1899 to 3rd January 1900 and from 20th April to 30th September 1900.
Mr. S. O. Madras, Extra Assistant Superintendent, 6th grade, from 19th February 1900.
Mr. P. K. Vaughan, Sub-Assistant Superintendent, 2nd grade, to 8th August 1900.

Native Draftsmen.

Munshi Abdul Aziz.
" Abdul Ruzzaq.
Babu Bacharam Banerji.
" Ram Chandar Sen.
" Tincowri Sen and 19 others.

Sub-Surveyors, etc.

Babu Rhidoy Chandar Das.
" Satiya Charan Ghosal.
" Kali Podo Chowdry.

* Messrs. Green and West have both worked satisfactorily and done their best, and among the Native Establishment Surveyor Sher Shah and Draftsmen Babu Purna Chandra Sen, Noorul Hassein, Bepin Behary Ghose and Chuni Lall Dutta have given satisfaction.

maps of Calcutta on the scales of 6 inches=1 mile and 3 inches=1 mile, which were at press at date of last report, were again largely added to and corrected from local information as well as fresh professional survey and have been in hand throughout the year. They will shortly go to press for, it is hoped, final proof. The originals have been so much patched that a new map must ere long be taken in hand.

358. Of standard maps the following sheets of North-Western Provinces and Oudh were corrected to date and published during the year under report. Sheet No. 14 on the scale of 1 inch=1 mile of Saháranpur and Nos. 63 $\frac{S.E.}{1 \text{ and } 4}$, 64 $\frac{N.E.}{4}$, $\frac{S.E.}{2 \text{ and } 4}$, and 257 $\frac{N.W.}{1, 2, 3, \text{ and } 4}$ of NainiTal district on a scale of 4 inches=1 mile. Eight sheets of Muzaffarnagar, Saháranpur, Meerut, Moradabad, and Bijnor districts were brought up to date with additions to boundaries, roads, etc., and 31 sheets of Aligarh, Agra, Muttra, Gházipur, Benares, Mirzapur, Basti, and Gorakhpur districts were similarly dealt with as far as materials were available and sent to press. The compilation of sheet No. 27 referred to in paragraph 351 of the last report is still in hand, but the incorporation of the forest survey work of a different scale and style is slow work and the sheet is yet far from completion.

Of the standard sheets of Bengal, Nos. 269 and 270 of Darjeeling district have been corrected from materials supplied by local officials, and sent to press. Of Hooghly and Howrah districts 7 sheets have been corrected in a similar way and will be despatched to press very shortly. Sheets Nos. 347, 348 and 389 of Mymensingh district have also been in hand. Proofs of the first two are under examination, while the last is at press. Sheets Nos. 235, 236, 237, 258, 259, 260 and 281 containing portions of Birbhum and Murshidabad districts and the Sonthal Parganas have been touched up, brought up to date as far as possible and sent to press for republication. Sheet No. 282 of the same series is also in hand. Three sheets of Dinájpur district, two sheets of Midnapore and two of Cooch Behar were corrected from information supplied by the local officers.

359. Of Assam standard sheets Nos. 68 and 69 of Cachar district were corrected and sent to press and sheet No. 69 has been published. Eighteen fair sheets of Nowgong, Goálpára, Kámrúp and Darrang districts were completed and sent to press. Proofs of 14 of these have been examined and those of the remaining 4 are now under examination.

Standard sheets Nos. 201, 202, 206 and 232 of Bombay were published and 7 other sheets are now passing through the press. Sheets Nos. 133 $\frac{S.E.}{2, 3}$, 134 $\frac{N.E.}{2}$, and 134 $\frac{S.E.}{4}$, $\frac{S.E.}{1, 3}$, etc., on the scale of 1 inch=4 miles of Thána district have been published and 8 sheets of this district are under publication. Sheets Nos. 9 and 66 of Sind have been corrected and brought up to date from information supplied by local officers.

360. Of the standard sheets of Burma Nos. 156, 157 of Minbu district, and 259 of Prome were published. Sheets Nos. 467, 468, 469, 470, 529 and 530 of Tavoy; 161 of Prome; 123, 125, 260 of Hanthawaddy and Pegu; 163 of Henzada; 110, 111, 112 of Minbu; and 170 and 171 of Bassein are passing through press. Seven 2-inch fair maps in 28 sections of Pegu, Tharrawaddy and Toungoo districts were examined and reported upon. Blue print reductions of 16 sheets of Meiktila and Yaméthin districts were supplied to No. 10 Party to facilitate revision work in the field. A large number of standard sheets drawn on the 2-inch scale for reduction to half have been received from the field parties, but as these are compilations from the cadastral surveys and many of them contain hilly ground that has not been surveyed, they cannot be published until the hills have been surveyed by the topographical parties now engaged on this work.

361. In addition to the above 9 old sheets of Jessore district (30′×20′) were corrected and sent to press for republication; 2 sheets of Monghyr and 14 sheets of Panchánnográm survey were touched up, corrected and sent to press for reproduction; 18 Pargana maps of Bhágalpur, Nadia, 24-Parganas, Cuttack and Dacca districts had corrections carried out to roads, boundaries, etc., from local officers' plans.

The republication of old maps from the printed sheets can only give most inferior results, but is the only course possible, the originals having been drawn in colours, and as the survey is out of date it is not worth while redrawing them. Even the maps of the country round about Calcutta are of this kind, as nothing modern is available.

362. A large amount of mapping has as usual been done for other departments. The Contour map of the station of Naini Tal on the scales of 10 and 20 inches=1 mile was published for the local Government. The Ward map of Calcutta on the 3-inch scale is in hand. A skeleton map of Umballa district scale 1 inch=4 miles was prepared for the Director, Land Records, Punjab, and 120 tracings of congregated village sheets, and 42 village plans were made and supplied to various district officers; 82 maps have been coloured for office use and 21,166 maps coloured for stock in the Map Record and Issue Office were examined. The comparison of the sample sheets from which copies for issue to the public are made, with the office copies on which corrections are from time to time entered has been commenced, and 920 sheets have been compared. This work has, from lack of hands unfortunately to a great extent fallen into arrears and can only be slowly effected now, but it is hoped the arrangements now made will ensure sheets being more systematically kept up to date in future.

363. A large number (443) of computation volumes received from field parties were cursorily examined and reported on. The traverse computations of the Thatôn district of Burma and Goálpára of Assam extending over 3 seasons were thoroughly examined during the year. Those of Muzaffarpur district of Bengal extending over seasons 1891—95 are in hand.

364. Copies of traverse data, the calculation of areas etc., have, as usual, been prepared in this office and supplied to field parties and district officials. Of traverse data, 2,076 pages have been copied and supplied.

Traverse circuits were computed and plotted on a scale of 4 inches=1 mile for the preparation of congregated village maps of 4 groups of villages in Malda, Monghyr, Purnea and Murshidabad districts for local officers. Area statements of Ránchi, Palámau, Nowgong, Sibságar, and Gáro Hills districts were prepared and the area statements of Cuttack, Balasore and Puri districts were revised for local officers. The areas of *tahsils*, circles, etc., were computed for sheets 202, 238 and 243 Bombay; 260 Burma; 52 and 54 Peshâwar; 430 C. I. topographical survey; Belgaum cantonment and of certain forest reserves in Burma.

365. A Zenith Sector scale for No. 24 Party and scales of 16 inches=1 mile, 48 inches=1 mile and 50 feet=1 inch were prepared. Spherical values of 65 Revenue Survey stations in sheets Nos. 240, 243, 244 (Burma) were computed. Similar values for districts Sibságar, Sylhet, Jálaun, Noákháli, Chittagong, Jubbulpore and Pegu were computed and supplied.

366. A statement showing cost of (*a*) traverse, (*b*) demarcation, (*c*) cadastral survey and (*d*) record of rights for the Orissa division from 1886 to date was prepared; also a slightly modified similar statement for Chittagong for the Settlement Officer, and of Lalitpur for the Collector of that district.

A statement detailing the nature of the traverse operations which had been carried on in connection with the old revenue surveys of the Punjab was prepared for the Surveyor-General, and a similar more amplified statement for the Settlement Commissioner.

367. Applications for manuscript copies of maps numbered 860, and all were disposed of during the year. The correspondence in connection with this work amounted to 1,357 letters. The total number of other letters dealt with during the year was 859.

A sum of R1,119-4-0 was received on account of Government fees.

368. Much inconvenience has been caused by the demands of the various parties and others for data required for the coming season's work, all being sent in during September. A little forethought as to their requirements on the part of indenting officers would save them inevitable disappointment and the office a press of work which cannot be disposed of in a limited time, without undue strain on the establishment.*

* Major Fleming reports well of Messrs. Hill and Penrose. Of the native staff Munshi Abdur Ruzzaq is especially commended, Munshi Abdul Aziz, Babus Tincowri Sen, Rhidoy Chandar Das, Bacharam Banerji and Rash Bihari Sen being also brought to notice.

SECTION III.—CADASTRAL.

369. This section prepares the original maps of all cadastral surveys for photozincography and zincography, after submitting them to a cursory examination in order to see that they are in every respect fit for reproduction.

Personnel.

Mr. W. H. D. Ewing, Sub-Assistant Superintendent, 1st grade.

Permanent Establishment.

6 Draftsmen. 1 Writer.

Temporary Establishment.

6 Tracers

370. In Burma the returns for the previous year showed 2,694 sheets remaining to be published, and during the past twelve months 3,788 original sheets of Katha, Magwe, and Shwebo districts of Upper Burma and of Mergui town and the Pegu and Toungoo districts of Lower Burma were received from the parties. Out of these 3,522 sheets have been published, leaving a balance of 2,960 to be printed, of which 400 have been prepared for publication. Fourteen sheets of district Sagaing were reprinted.

371. In Bengal the returns for the previous year showed 411 sheets of Tikári Ward's Estate, district Gaya, remaining to be published, and during the year 54 sheets have been added. Out of this total, 213 sheets have been published, leaving a balance of 252 of which 120 have been prepared for publication.

372. In Assam the returns for the previous year showed 493 sheets remaining to be published, and during the past 12 months 174 original sheets of district Cachar were received. These have all been published during the year. The districts remaining incomplete are Kámrúp (8 sheets), Sibságar (8 sheets) and Sylhet (45 sheets). These are mostly blocks and waste lands and, under existing orders, are not to be printed.

373. The total number of maps passed for publication during the year was 4,488, of which 4,402 were actually printed, 3,359 having been photozincographed and 1,043 zincographed. At the close of the year there were remaining to be published 3,273 sheets against 3,659 sheets in last year; showing a decrease of 386 sheets.

374. In addition to this a good deal of miscellaneous work has been done for Collectors, Settlement Officers and others. The services of two permanent draftsmen were engaged for the major portion of the year in *badar* corrections of Upper and Lower Burma and of the field area statements of Tippera and Noákháli districts.

SECTION IV.—BENGAL PROVINCIAL.

375. The only cadastral maps dealt with during the year were those of the Muzaffarpur, Champáran, Sáran and Darbhanga districts of Bihar. The total number received from the field during the year was 2,145, and there remained to be dealt with at the close of last year 2,883, making a total of 5,028. Of these 3,175 were reduced by pentagraph to the scale of 2 inches=1 mile for the preparation of the standard maps, leaving a balance of 1,853 to be dealt with next year.

Personnel.

Mr. A. B. Smart, Extra Assistant Superintendent, 6th grade.

Permanent Establishment.

6 Draftsmen.

Temporary Establishment.

6 Computers, Writer, etc.
5 Draftsmen.

376. Of the standard sheets of Bihar 10 were projected, 12 outlined and 24 completed and finally examined, but as lists giving the correct spelling of the village names had not been received from the Settlement Department, these sheets were not forwarded to the photographic office for publication. Of the sheets of Chittagong district, 60 in number, the pentagraphed reductions of 12 were transferred to the fair maps and the outlining and typing of 8 sheets completed, bringing up the total number of sheets of this district, of which the drawing has been completed to 24.

377. Four standard sheets of Orissa were projected, drawn, examined and reduced by photography to the scale of 1 inch=1 mile during the year under report, the total number which has now been completed being 128. Of the special edition of 26 standard sheets of Orissa on the scale of 2 inches=1 mile called for by the Government of Bengal, showing the irrigated area,

9 were published during the year under report, bringing the number published to 18, and leaving a balance of 8, which have all been forwarded to the photographic office for reproduction.

Owing to numerous corrections to the village names made on the proof standard sheets of Bihar and Orissa by the Settlement Department, although the names were taken from the original cadastral maps, it was found necessary to re-type a very large percentage of the names on the fair maps and have them again reduced by photography. This has considerably delayed the publication of the maps.

ENGRAVING OFFICE.

378. Mr. Spring held charge of this office until the 28th June, when he proceeded on privilege leave and Major Fleming officiated for him until the end of the year. Mr. S. M. Coard performed the duties of Head Engraver to 28th June, when he was temporarily transferred to the Lithographic Office, and during his absence his duties were carried on by Mr. A. R. Coard.

Personnel.

Mr. A. E. Spring, Assistant Surveyor-General, in charge up to 28th June 1900.
Major J. M. Fleming, I.S.C., Officiating Assistant Surveyor-General, in charge from 29th June 1900.
Mr. S. M. Coard, Head Engraver, to 28th June 1900.
Mr. A. R. Coard, Assistant Head Engraver, officiating Head Engraver, from 29th June.

Mr. A. W. N. James,	Engraver.
„ E. Earle,	„
„ F. R. C. Scallan,	„
„ E. C. Ollenbach,	„
„ L. H. Musgrove,	„
„ A. T. Vieux,	„
„ A. E. W. Cann,	„
„ H. H. Green,	„
„ R. Rodger,	„

30 Native Engravers.
1 Apprentice.

Copperplate Printing Section.

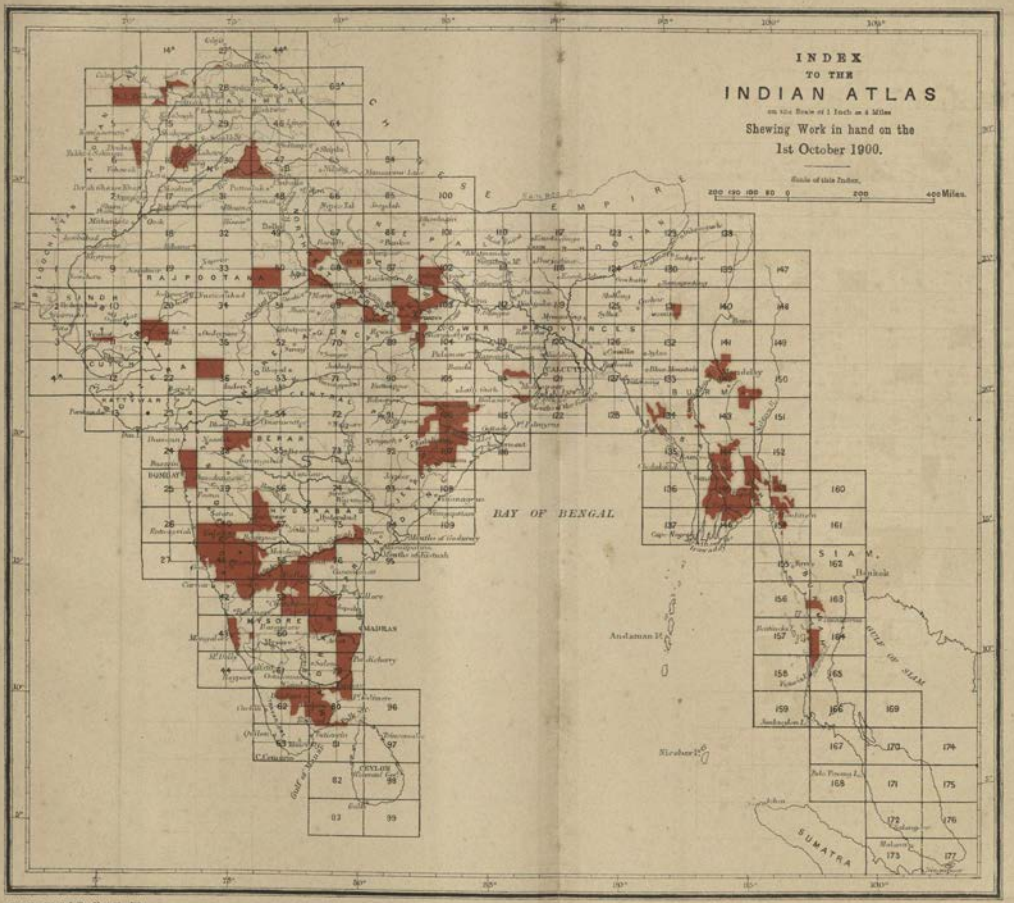
Mr. W. S. Collins, Copper-plate Printer, on furlough.
Mr. A. E. Pilley, Officiating Copper-plate Printer.
Mr. B. C. Gasper, Officiating Assistant Copper-plate Printer and Storekeeper.

379. The outturn of work has been satisfactory, that of outline being 4,890 square inches, which is in excess of last year's by more than 1,000 square inches, thus fully compensating for the shortness in writing, as only 308,000 letters have been cut against 348,548 cut last year. Nine hundred and ninety-three square inches of hills have been etched and 1,528 square inches of tints, etc., ruled. Two plates for the Longitude Volume, 7 scale-plates and 5 tint-plates have been completed.

380. As the work to be done this year consisted principally of new material on new quarter sheets, the number of Atlas sheets completed and published has been 3 only. New material has been added to 75 quarter Atlas sheets which are in various stages of progress, making 2 more plates than were dealt with for new material last year; 39 published quarter and 6 full sheets were brought up to date with new railways, spelling and boundaries, some of the plates having heavy additions and corrections carried out on them. Thirty-four new plates have been projected or had the borders cut.

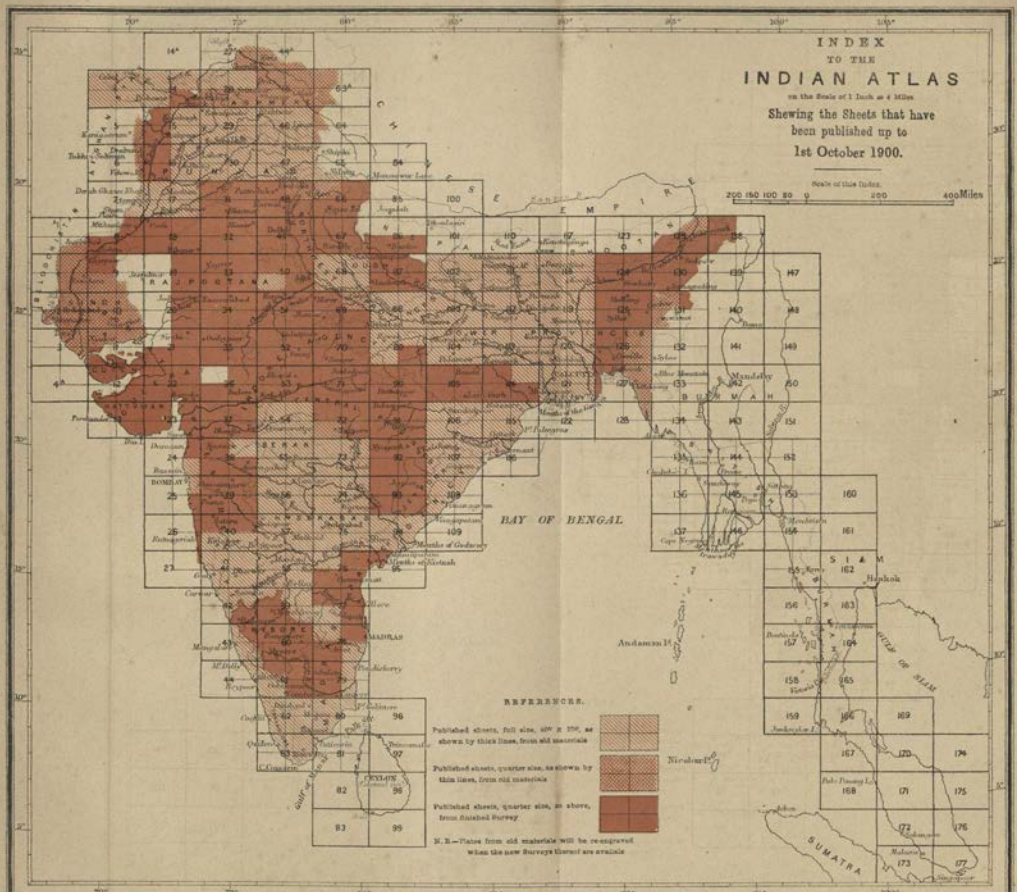
381. The maps of India on the 64-mile scale, both with and without hills, have been in hand with heavy additions to railways to bring them up to date. As it will be some years before the new map on this scale will be completed, it has been decided to bring the present map with hills up to date with railways and to correct on the duplicate plates the spelling, boundaries and railways and add new material both in Burma and Balúchistán. Work on these duplicates has been commenced and they will be pushed on as fast as possible. India on the 80 miles scale is being brought up to date with railways and spelling. The new 128-mile map has been completed with hills and is waiting for the completion of the railways to date before being published. This map, without hills, on the same scale has been corrected with railways to date. The hills on the 256-mile map have been completed and the plate is waiting to have the railways brought up to date before being published. The route map of the Western Himalayas on the 32-mile scale has been corrected as far as material is available up to the Punjab boundary, but heavy corrections have yet to be carried out in the trans-frontier portion, and it will be a considerable time before the map will be ready for issue.

382. A small portion of new survey has been engraved on the 16-mile map of Bombay Presidency, and the 6 sheets of the map of the Madras Presidency are almost completed in outline and writing. The new material on the



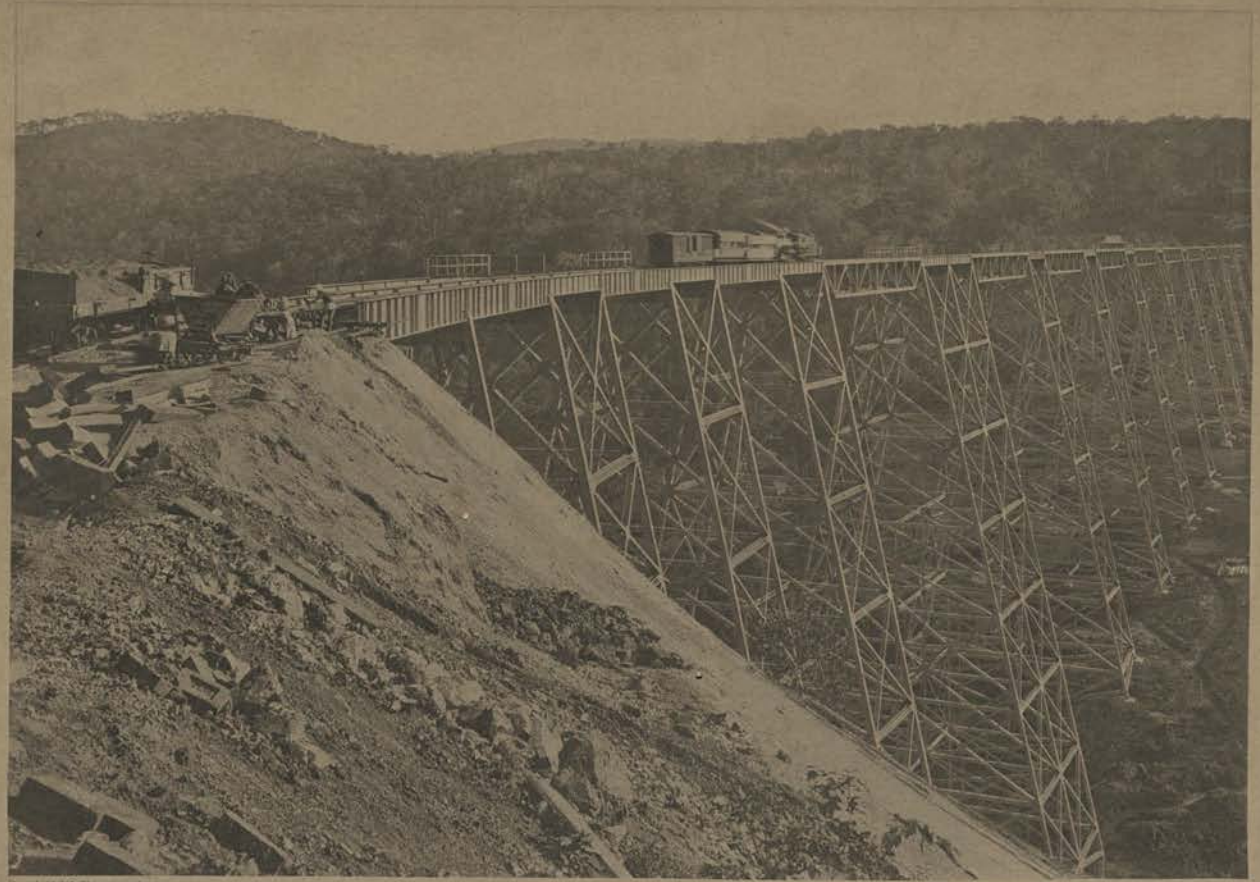
Reg. No. 523. S. I. D.—Nov. 03.—800.

Litho., S. I. O., Calcutta.


INDEX
TO THE
INDIAN ATLAS
on the Scale of 1 Inch to 4 Miles
Shewing the Sheets that have been published up to
1st October 1900.
Scale of this Index.
200 150 100 50 0 200 400 Miles
BAY OF BENGAL
REFERENCES.
Published sheets, full size, 20" x 27½, as shown by thick lines, from old materials
Published sheets, quarter size, as shown by thin lines, from old materials
Published sheets, quarter size, as above, from finished Survey
N. B.—Plates from old materials will be re-engraved when the new Surveys thereof are available
MADRAS
CEYLON
Andamans
Nicobars
SUMATRA
Mandalay
Hankok

Sig. No. 239. S. I. D.—Dec. 00.—700.

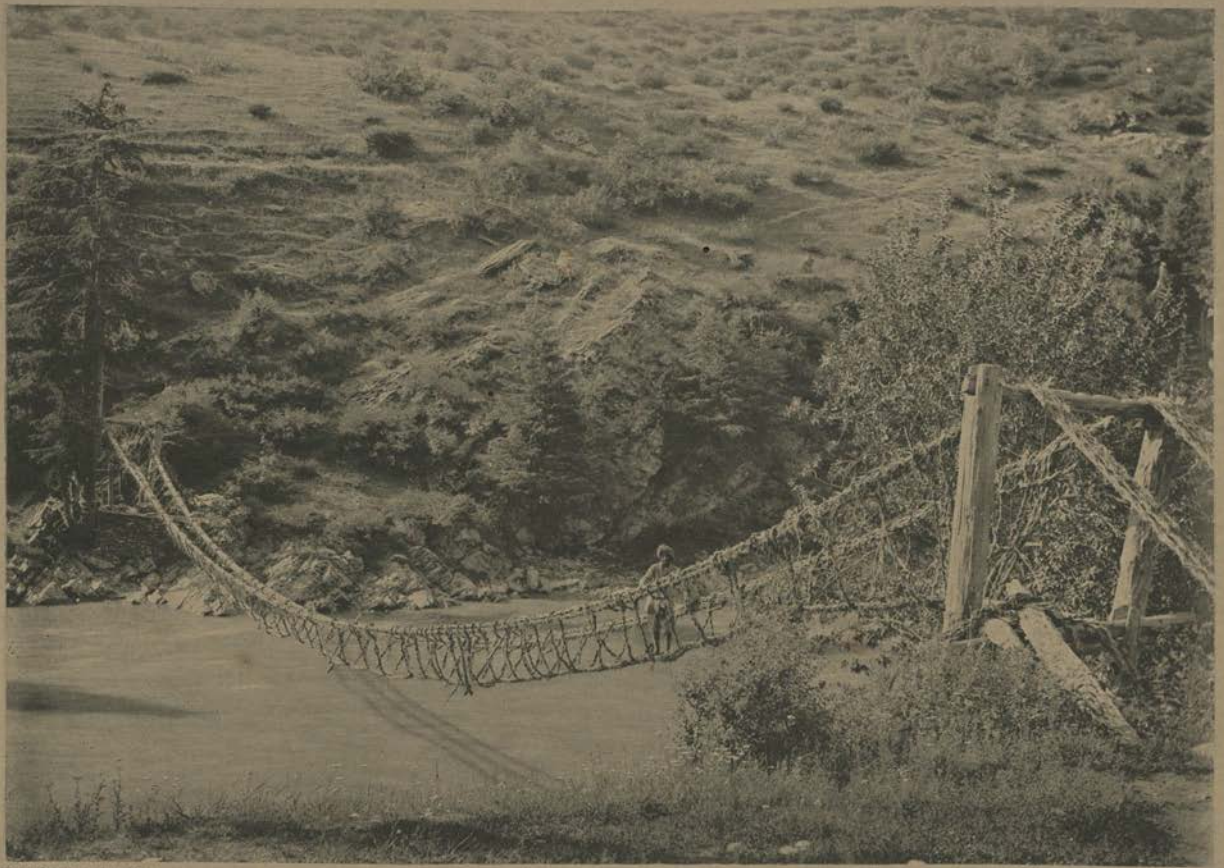
Litho., S. I. O., Calcutta.



Capt. F.W. Pirrie, photo

Photogravure, Survey of India Offices, Calcutta, February 1901.

THE GOKTEIK BRIDGE, MANDALAY-KUNLON RAILWAY.



Capt. G.A. Beazeley, photo.

Photogravure, Survey of India Offices, Calcutta, January 1905.

ROPE BRIDGE OVER KISHANGANGA AT SHARDI

16-mile map of the Punjab in four sheets has been completed as far as supplied, but some further material will have to be engraved before this map can be published. On the 32-mile map of the Punjab heavy additions have been completed in outline. The maps of Gujarát, both with and without hills, Central Provinces in two sheets, Bengal in two sheets, Mysore and N.-W. Provinces and Oudh in two sheets all on the 16-mile scale; Berar 1 inch=8 miles, and the map of Bengal 1 inch=64 miles, have had additions and corrections carried out on them. The provincial maps of Central Provinces and Central India Agency on the 80-mile scale, for administration reports, have been completed in outline and the writing is being engraved; 7 other plates of provincial maps and 24 plates of district maps (besides those mentioned as published) for administration reports, and 7 chart plates have been added to and completed, while 35 plates have been completed with titles, etc., for the Photo-Litho. and M. I. Offices. Taking into account all plates on which work of some kind or other has been done, 281 sheets have been dealt with.

383. The process of carrying out corrections on the face of the plates and filling in electro deposited copper has been carried on during the year; 22 plates having been so dealt with. By this process some of the plates were brought up to date much more completely than could have been done by knocking up the corrections from the back.

384. The Copper-plate Printing Section pulled 23,754 impressions. This section is too small to be able to cope with the demands now made upon it, and the printing of 2 or 3 copies from the plates has been the only possible way to meet urgent demands; but as this entails a great waste of time and a great wear and tear upon the engraved plates, it has been decided as the plates are brought up to date to put transfers on zinc, and print copies for stock and issue from these until some arrangements can be made to enable a stock of copies to be printed from the engraved plates. The Steel-facing Section dealt with 211 plates.*

THE PHOTOGRAPHIC AND LITHOGRAPHIC OFFICE.

385. Mr. T. A. Pope continued in charge of this office throughout the year. Mr. Fogarty proceeded on three months privilege leave in June 1900, and in his absence Mr. Coard, Head Engraver, officiated for him. Mr. Turner also took privilege leave for three months in July 1900, his duties being performed by Mr. Gonsalves. Mr. George, Photographer in charge of the Transfer-printing section, died on the 11th November 1899, after a long period of service in the office, and the loss of his services is much regretted. He was a steady and experienced assistant.

Personnel.

Mr. T. A. Pope, Assistant Surveyor-General in charge.

First Division.

Mr. R. Fogarty, Head Assistant, Litho. Branch, up to 28th June.
„ S. M. Coard, from 29th June.
„ H. Haward, Head Assistant, Photo. Branch.
„ A. W. Turner, Photo-Engraver.
„ F. R. Vandyke, Foreman Litho. Printer.

Second Division.

Mr. E. A. LeFranc, Assistant,
„ R. George, „ up to 11th November,
„ D. Deas, „
„ L. Lagnier, „
„ T. Lloyd, „
„ J. B. Mackenzie, „
„ E. DePyvah, „
„ C. J. Meade, „
„ S. U. Ravenscroft, „
„ P. Michael, „
„ A. J. J. Rodrigues, „
Babu Ambica Churan Mukerji, „
Mr. C. Andrews, „
„ F. N. Murphy, „
Munshi Abdul Mujeed, „
Mr. N. J. Gonsalves, Assistant,
„ J. Vieux, „
„ J. D'Silva, „
and 4 Apprentices.

Third Division.

Munshi Mohamed Yasin, Sub-Assistant.
„ Abdul Hakim, Sub-Assistant.
„ Abdul Rahman, Sub-Assistant.
„ Hyder Ali, Sub-Assistant,
and 52 Sub-Assistants.

Fourth Division.

49 Press Assistants.

Correspondence, Stores and Account Section.

Babu Kanny Lall Sen, Head Clerk,
Mr. A. B. Carville, Clerk,
and 11 Clerks.

Inferior Establishment.

1 Fireman.
9 Machinemen.
150 Spongemen, Grainers, Pressmen, etc.

386. An abstract of the work performed during the year in each section of the office is given in the following statement:—

* The Assistant Surveyor-General reports that both the Messrs. Coard and all the Engraving staff have performed their duties satisfactorily.

General abstract of Work done during the year 1899-1900.

Classification.	Sheets or Subjects.	Negatives.	Photo-zincographic and Lithographic Printing.									Type Printing.			Silver and other Printing.		Heliogravure and Electro-typing.				Value.
									Number of copies.												
		Negatives and transparencies.	Photo-transfer prints.	No. of Zinc plates prepared from Photo. Transfer.	Zinc plates prepared by direct process.	Zinc Plates printed.	Stones.	Pulls.	Coloured.	Uncoloured.	Total.	Pages or items.	Pulls.	Copies.	Silver Prints.	Blue Prints.	Heliogravure Plates.	Heliogravure Prints.	Photo. Blocks.	Electrotypes.	
																					R a. p.
Departmental maps . .	983	1,125	819	304	...	356	63	140,907	21,997	77,179	99,176	15,146	1,478,081	812,127	24	2,010	2	2,077	5	5	53,480 0 3
Cadastral maps .	4,942	3,446	3,459	4,428	458	4,786	...	171,873	...	162,733	162,733	...	...	...	...	...	...	...	...	...	66,432 13 9
Extra-Departmental maps and Plans, &c.	1,534	1,099	645	1,135	5	1,113	338	697,273	133,597	449,996	588,593	...	...	...	947	332	58	54,493	17	...	94,502 12 6
Total .	9,459	5,670	5,413	5,377	463	6,255	401	1,010,053	160,594	689,908	850,502	15,146	1,47,8081	812,127	971	3,292	60	56,570	22	5	214,415 10 6
Total for 1898-99 . . .	6,873	55,67	5,711	5,505	...	5,548	473	982,220	138,181	827,272	965,453	13,932	12,77,949	684,039	120	1,631	126	36,514	78	8	217,622 2 6
Differences . .	+ 586	+ 103	— 298	— 133	+ 463	+ 707	— 77	+ 27,833	+ 22,413	— 137,364	— 114,951	+ 1,214	+ 200,132	+ 128,088	+ 851	+ 761	— 68	— 29,944	— 56	— 3	— 3,206 8 0

The outturn of the year, as shown in this statement, is again somewhat above the average. The actual number of printed copies turned out by the Lithographic and Zincographic machines and presses is less than the very large outturn of last year, although the number of original subjects dealt with is considerably greater. This is due to the fact that the proportion of departmental maps reproduced was larger during the past year, and the number of copies printed of departmental maps averages lower than in the case of the miscellaneous work turned out for other departments, though the amount of work involved in preparing them for publication is necessarily very much greater. The number of original maps received for reproduction, and either completed or in progress at the close of the year was 7,459, or 586 in excess of last year. The excess is entirely in departmental maps, the number of subjects received from other departments being practically the same as last year. The total outturn of maps, plans, etc., yielded by the machines and presses amounted to 850,502, as against 965,453, last year. Of these, 99,176 were of ordinary departmental maps, as against 135,094 last year; 162,733 were copies of cadastral maps, of which 136,630 were printed last year, and 588,593 were extra-departmental subjects, as against 693,729. This very large amount of work done for other departments, all of which was of an urgent nature and could not be declined without causing much trouble and inconvenience, has again interfered seriously with the publication of the standard sheets of the topographical and revenue surveys, of which a large number are still awaiting publication. The Assistant Surveyor-General again brings to notice the urgent necessity for the small increase of establishment in the Zinc-printing section mentioned in paragraph 372 of last year's report, without which it will be impossible to clear off these arrears and to prevent them from accumulating in the future. The outturn of type-printing has increased materially during the year, the number of pages or items set up being 15,146, as against 13,932 last year, and of copies 812,127, as against 684,039. The work done in the Heliogravure section shows a considerable decrease, owing to smaller demands for photogravure and other photo-mechanical work. The number of prints made from photo-etchings was only 56,570, or about 30,000 less than last year. There was, however, a large increase of work in the Silver-printing section, the number of silver prints made rising from 120 last year to 971, and of cyanotype prints from 1,631 to 2,392. The total value of the work done in all sections was R2,14,416, as against R2,17,622 last year.

387. The following are the principal departmental maps dealt with during the year:—

The third edition of the 32-mile map of India, with hills, in six sheets, which was reported last year as having been finally published, was again taken up and considerable additions and corrections were made to all the sheets. New proofs were supplied, and at the close of the year press order had been given for five of the sheets.

Of provincial maps, a skeleton map of the Punjab and surrounding countries, on the 32-mile scale, was lithographed and 650 copies printed off. A map of Sind, on the 80-mile scale, was printed from stone and 100 copies supplied. Maps of Alwar State, Rájputána and of the Rájputána Agency, on the 16-mile scale, were also lithographed, and 200 copies of the former and 120 of the latter printed off. A map of the province of Bengal, on the 32-mile scale, was lithographed in colours and 650 copies printed.

The following district maps were printed off:—Jhelum and Shahpur (sheet No. 6), and 24-Parganas, on the 1-inch scale; Pesháwar, under the jurisdiction of the Lieutenant Governor, on the $\frac{1}{2}$-inch scale; Kámrúp, Sibságar, Lakhimpur, Nowgong, Darrang, and Khási and Jaintia Hills, on the $\frac{1}{8}$-inch scale, photo-zincographed. Hoshangabad, Midnapore and Mymensingh, on the $\frac{1}{4}$-inch scale, and Káthiáwár, on the $\frac{1}{16}$-inch scale, lithographed. Besides the above, a considerable number of other district maps were in various stages of progress at the close of the year.

Of plans of cities and cantonments, a map of Simla and Jutogh, on the 6-inch scale, was photozincographed, and several sheets of the Calcutta town map, on the scale of 50 feet to 1 inch, were brought up to date and reprinted.

Four hundred and ninety-five standard sheets of the topographical and revenue surveys on the 4-inch, 2-inch, 1-inch, $\frac{1}{2}$-inch, $\frac{1}{4}$-inch and $\frac{1}{8}$-inch scales were dealt with during the year, either as new publications or as reprints. One

hundred and seventeen plates were printed off, including 65 sheets on the 1-inch scale, comprising 2 of Assam, 6 of Bengal, 2 of Bombay, 27 of Upper Burma, 10 of Lower Burma, 5 of the Central Provinces, 16 of Central India and Rájputána, 2 of Hyderabad, 2 of the Lower Provinces survey, 1 of Madras and 1 of the Punjab. Nineteen sheets of the Punjab survey, on the 2-inch scale, and 9 sheets of the North-Western Provinces and Oudh, and 5 sheets of Lower Burma, on the 4-inch scale, were printed off. Of the Trans-frontier surveys, 1 sheet on the 1-inch scale and 12 sheets on the $\frac{1}{2}$-inch scale of the North-West Frontier series; 1 sheet on the $\frac{1}{8}$-inch scale and 1 sheet on the $\frac{1}{8}$-inch scale of the North-East Frontier series; and 1 sheet on the $\frac{1}{4}$-inch scale and 1 sheet on the $\frac{1}{8}$-inch scale of the South-East Frontier series were also printed off.

388. Of the miscellaneous departmental publications the following may be mentioned:—

A map of the Sundarbans, on the 1-inch scale; a map of the Eastern Nága Hills and Manipur, with the adjoining portion of Burma, on the $\frac{1}{4}$-inch scale, photozincographed and printed off. Forty-one maps on the $\frac{1}{4}$-inch scale, pertaining to the Burma-China Boundary commission were photozincographed, of which 23 were printed off. In addition to the above, a large number of sheets of the Madras Forest surveys were photozincographed as usual.

389. The number of extra-departmental subjects dealt with during the year was 1,534, or 13 more than last year.

The railway and canal map of India, on the 32-mile scale, in 6 sheets, proofs of which were submitted to the Railway and Irrigation branches of the Public Works Department in September 1899, has not yet been published. The proofs were returned in December and fresh proofs were submitted in April 1900. These were returned in July and contained further heavy corrections and additions, which are now being made. A third set of proofs will be ready about February 1901.

The 32-mile military map of India, in 6 sheets, was completed and proofs submitted to the Quarter-Master General in February 1900, but these had not been returned at the close of the year.

For the Telegraph Department, 3 sheets of a new Telegraph map of India, on the 32-mile scale have been in hand for lithography during the year, but the work is now in abeyance, the originals having been called for by the Director General of Telegraphs. The Traffic chart of India for the same department was brought up to date and proof supplied. Another Telegraph map of India, on the 64-mile scale, was put in hand during the year.

For the Government of India, Revenue and Agricultural Department, a set of plans and drawings to illustrate Babu P. C. Mukerji's report on Kapilavastu (Nepál) were lithographed or photozincographed, and copies supplied. A map of the Nizam's Dominions, to accompany a list of antiquarian remains, was photozincographed and copies supplied.

For the Government of India, Home Department, a map of India to illustrate the report of the Sanitary Commissioner was lithographed in colours and printed off. Four maps were prepared for Mr. Grierson's Linguistic survey, and proofs supplied in colours.

For the Government of India, Public Works Department, the usual Railway maps on the 80-mile scale, showing gauges and system of railways, and existing and proposed railways, were lithographed in colours and printed off.

For the Public Works Department, Punjab, an Irrigation map of the Punjab, in four sheets, on the 1-mile scale, which was in hand during 1899, was completed and proofs supplied.

For the Quarter Master General in India a sketch map illustrating the distribution of the various tribes represented among the Sikhs was photozincographed; also a map of Mid-China and the Yangtse River, and of China and surrounding countries, in two sections. For other military authorities, 56-mile radius maps of Agra, Allahabad, Bareilly, Fyzabad, Goona, Lucknow, Meerut, Muttra, Nowgong and Saugor, on the 4-mile scale, were photozincographed and printed off. Manœuvre maps of the country 10 miles round Allahabad (in English, Urdu and Hindi) Barkacha, Bolarum, Dehra Gházi Khan, Edwardesabad, Kohát, Sitapur and Saugor; and of the country 14 miles round Meerut and Lucknow (in Urdu and Hindi) on the 1-inch scale; a 12-mile radius map of

Mhow, on the 2-inch scale; and sketches of the country round Miran Shah post and Boya post, Tochi Valley, were either photozincographed or lithographed, or reprinted from old plates.

During the year, 203 sheets of the Rangoon town survey were transferred to zinc and proofs supplied, and 295 sheets were printed off for the Rangoon Municipality. The entire work on this map, which has occupied 18 months to execute, will be completed during the month of October 1900.

As usual, a large number of maps and charts were reproduced for the Meteorological Department, of which 181,126 copies were printed and supplied.

390. In the Heliogravure section somewhat less work was done than usual. The usual twelve plates were prepared for the Technical Art series, and 800 copies of each were printed. The illustrations were wholly confined to metal-work, the subjects being selected by the Superintendent of the School of Art, Calcutta. Seven plates were photo-etched to illustrate the *Palæontologia Indica*, issued by the authorities of the Indian Museum, and 450 copies of each were printed. As usual, 12 plates illustrating the zoology of the R. I. M. S. *Investigator* were prepared and 250 copies of each supplied. For the memoirs of the Geological survey two plates were prepared and 1,025 copies of each printed. Babu Mukerji's report on Kapilavastu was illustrated with 6 plates, 500 copies of each being printed, and for a report on the Mathura antiquities, for the Public Works Department, North-Western Provinces and Oudh, 5 plates were prepared and 500 copies of each printed. There was not much demand for half-tone blocks during the year, and only 22 were prepared.

391. The invention of a new method of reproducing line drawings direct on zinc, which is much cheaper than photozincography and at the same time superior in its results, provided that the original has been suitably drawn, has enabled the office to undertake a large quantity of work for the Government of Bengal which could not otherwise have been undertaken owing to the expense involved. This work consists of the reproduction of the cadastral sheets of Orissa, of which 8,300 are being reproduced at the rate of 24 daily, and 10 copies of each supplied. On the completion of this number it is understood that about 20,000 more sheets will remain to be similarly dealt with. The process will also be useful for the reproduction of a large variety of miscellaneous work, but owing to the limited number of men available to work it, it is not at present possible to undertake much beyond the work already in hand for the Bengal Government. It is the invention of Sub-Conductor F. R. Vandyke, R.E., Foreman Litho-Printer, who has been granted a patent for it. A full description of the process as it is now being worked will be found in the Appendix.*

MAP RECORD AND ISSUE OFFICE.

Personnel.

Mr. A. E. Spring, Deputy Superintendent, 1st grade, in charge, up to 28th June 1900.
Major J. M. Fleming, I. S. C., Superintendent, 2nd grade, from 29th June 1900.
Mr. F. A. D'Rozario, Head Assistant.
" H. R. Vallis, Map-Curator, up to 13th December 1899.
" E. A. Bonnaud, Map-Curator, from 14th December 1899; and 16 other clerks.

392. The charge of this office was held, as shown in the margin, by Mr. Spring, until he went on furlough and handed over to Major Fleming, who remained in charge for the rest of the year.

* Mr. Pope reports that Messrs. Fogarty and Haward have worked most assiduously and given complete satisfaction in the discharge of their duties. Mr. Turner has also worked well. Sub-Conductor Vandyke has again shown himself to be a most valuable assistant, and has performed his duties with great energy and skill.

In the Second Division, Mr. LeFranc, Head Zinc Printer, has worked well; and Messrs. Lagnier, Mackenzie, Meade, Michael, Andrews, Murphy, Gonsalves, Vieux and D'Silva, in the Photographic branch; and Messrs. Deas, DePyvah, Ravenscroft, Rodrigues, Babu A. C. Mukerji and Munshi A. Mujid, in the Lithographic branch, have all continued to give satisfaction. The apprentices, Messrs. Francis, Wilson, Aratoon and Vallis have worked steadily and taken pains to improve themselves.

The following members of the Third Division deserve special commendation:—In the Lithographic sections, Mohamed Yasin, Enayetullah, Gossain Dass Nath, Amrita Lall Baral, Mahomed Kassim and Jebon Kristna Dey; and in the Photographic sections, Abdul Hakim, Hyderali, Sreenibas Pattra, Abdul Latif, Alimuddin and Abdul Wadood.

Of the clerks, Babu Kanny Lall Sen has continued to render good service and Mr. Carville has worked well. Babus K. M. Dass, G. C. Mukerji, S. K. Banerji, R. K. Chatterji, G. P. Pal, and N. N. Mukerji have also given special satisfaction.

393. The number and value of maps issued during the year are as follows:—

Maps Issued.	Number.	Value.
		R
General maps to Government officials	1,08,295	77,959
Ditto India Office, London	2,627	4,104
Ditto private individuals	7,631	8,975
Ditto agents	2,124	3,045
Cadastral maps to Government officials	1,48,032	1,85,040
GRAND TOTAL .	2,58,709	2,79,123

During the year under review, there has been an increase in the number and value of maps issued compared with those of the year preceding, which numbered 1,94,848, valued at R2,15,195; the increase amounting to 63,961 in number and R63,928 in value.

394. The amount realized from cash sales exceeded that of the previous year by R2,342. The sales during 1898-99 realized R20,916, whereas those of the past year were R23,258. Of this amount R9,887 were on account of maps sold to private individuals, R12,187 to Government officials, and R1,184 recovered from the several agents.

395. Upwards of 1,900 original plans were supplied to the Drawing Office to meet demands for tracings required by private individuals; and in addition 2,969 volumes of original records for reference, etc. Five hundred and twenty original volumes and maps were received from field parties, of which 92 maps and 299 computation volumes, being new, were registered and handed over to the Drawing Office for examination. The others (old records' returned) were stored away in their respective shelves; 123 volumes of original records and 735 original maps were also despatched to field parties. On comparing these figures with those of the previous year it will be found that a larger number of original volumes were supplied to the Drawing Office and a larger number of them were received for storage from field parties than during 1898-99.

The details of work done are specified in the following statement and generally show an increase over last year's figures. There has been a large increase in the number of coloured maps supplied and also an increase in the number of letters issued.

Details.	Number.
Applications received for maps	5,169
Letters issued	7,619
Cash and credit map sale bills	1,458
Invoices and receipts issued for published maps	3,493
Ditto Ditto cadastral „	162
Packets, parcels and local despatches	3,986
Ditto received	674
Packages despatched by rail and steamer	495
Ditto received ditto	167
Maps coloured for sale and issue	22,061
Ditto for other departments	2,501

396. The space available for storing maps has become quite insufficient for the requirements of the office. The larger scale maps have, for want of rack space, to be kept in bundles in the dark above the racks, and to get at them artificial light has to be used and a certain amount of risk of fire is incurred. To get sheets required from these rolls of maps also means a great loss of time, and it is to be hoped the additional rack space required, which has been applied for, may be soon provided, though this will only be a temporary remedy as the number of sheets coming in increases yearly.

The storage space for the original cadastral maps has also been used up and it has been necessary to keep the Bengal and Burma sheets in open racks instead of under lock and key as they should be.

397. It having been found that the colourists' sample maps from which coloured maps are prepared for issue, have not in some cases been kept up to date, a commencement has been made of a comparison between these and the copies of similar maps in the Drawing Office. This will take time, but it is hoped that the arrangements now made will obviate the possibility of a similar neglect of these maps in future.

A list of the maps and charts published during the year, copies of which have been regularly issued to the India Office, the several departments of the Government of India, and district officers, in keeping with standing orders, will be found at page 104.*

MATHEMATICAL INSTRUMENT OFFICE.

398. The figures in this report refer to the financial year, 1st April 1899 to 31st March 1900. During this period 57,160 serviceable instruments valued at R2,54,922 were received into store and 59,743 instruments valued at R2,88,770 were issued. Compared with the figures of the preceding year, the receipts show a decrease in both number and value, whilst the issues were considerably greater in value but somewhat less in number as shown below:—

Personnel.

Lieutenant G. A. Beazeley, R.E., Assistant Surveyor-General in charge, from 1st April 1899 to 22nd May 1899.
Captain P. J. Gordon, I.S.C., in charge, from 23rd May to 5th November 1899.
Major F. B. Longe, R.E., in charge, from 6th November 1899 to 9th March 1900.
Major J. M. Fleming, I.S.C., in charge, from 10th to 31st March 1900.

Workshop Branch.

Mr. T. R. Theakston, Mathematical Instrument Maker.
„ T. A. Ferrier, Assistant „ „
240 Artificers.

Store Branch.

Mr. M. C. Belletty, Instrument Store-keeper.
Babu W. C. Chowdhry, Material do.

Office Establishment.

Mr. W. Campagnac, Head Clerk.
„ W. R. Tulloch, 2nd do.
9 Clerks.

	1898-1899.	1899-1900.	Increase.	Decrease.
Number of instruments received	61,407	57,160	.....	4,247
Value of do. in rupees	2,84,208	2,54,922	.....	29,286
Number of instruments issued	72,514	59,743	.....	12,771
Value of do. in rupees	2,59,435	2,88,770	29,335	.....

* The Assistant Surveyor-General reports that Mr. D'Rozario, Head Assistant, has continued to perform his duties satisfactorily. Mr. H. R. Vallis died on the 13th December and his loss will be much felt in the office. The other clerks are also favourably reported on.

From the above table it will be seen that the number of serviceable instruments in store has decreased by 2,583, and their value has also decreased by ₹33,848.

399. The following statement shows the principal sources from which the serviceable instruments were received :—

	Number.	Value.
		₹
From England on indent	12,082	89,955
By purchase in local market	11,440	37,797
Manufactured in the workshop	21,577	27,662
Returned to store by public officials	9,335	7,624
From repairable stock after repair	2,725	91,882
From other sources	1	2
TOTAL .	57,160	2,54,922

The number of instruments received on indent from England has decreased by 2,542, and their value has also decreased by ₹8,413. This is due to the fact that the stock in hand did not require replenishing. The purchases in the local market were practically the same as last year in number, but their value has increased by ₹1,383.

400. The instruments manufactured in workshop have increased both in number and value. The manufactures depend entirely on the number of men who can be spared from the execution of repairs. The number of instruments taken from the repairable stock and rendered serviceable for issue is less, and their value when repaired is also less than that of the preceding year. This is due to the fact that the older patterns of instruments were taken in hand and converted to more modern types, which entailed a considerable amount of labour and time.

401. During the year the office received 4,238 repairable instruments valued at ₹49,229 compared with 3,311 valued at ₹55,760 received in the preceding year. The total issues from the repairable stock were 2,725 valued at ₹59,502. These were repaired in the workshop at a cost of ₹32,380 and transferred at an enhanced value to the serviceable stock. The repairable stock has been increased by 1,513 in number, but its value has decreased by ₹10,273. The decrease shows that the workshop has been able to cope successfully with the amount of repairable instruments returned to store and at the same time to meet all current demands thereon.

The conversion and repair of old pattern levels and theodolites alluded to in paragraph 381 of last year's report has been steadily continued, and during the year 140 levels and 98 theodolites have been converted into serviceable instruments. Since the increased establishment for the repair of instruments has been sanctioned, as already alluded to in previous reports, 627 levels and 290 theodolites have been rendered serviceable and all indents for levels and theodolites, except those for Railway or special pattern theodolites, have been complied with from this source, and indents on England for such instruments have been discontinued.

402. The cash payments for charges under ₹50 amounted to ₹50,587, being a little less than those of last year.

403. The number of indents complied with was 1,439, being 43 in excess of last year's. They were of the usual description and were received from all parts of India.

The value of English indents for 1899-1900 is £5,175, and those for the previous eight years are shown in the following table:—

Years.	Value.
	£
1891-92	8,464
1892-93	8,128
1893-94	13,875
1894-95	12,981
1895-96	5,208
1896-97	5,079
1897-98	3,995
1898-99	5,090

404. The value of issues and repairs executed on book-debit for various officers and departments is ₹2,57,207 being in excess of last year's by ₹29,668. This amount includes the value of instruments purchased with the extra-departmental grant of ₹30,000 of which ₹29,944 is expended. The credit of instruments returned into store amounted to ₹56,399, which is a decrease on the previous year's credit. The total value of instruments supplied, including the cash sales, is ₹3,07,794 or about ₹29,600 in excess of the value of last year's supplies.

The total number of instruments of all kinds repaired for public officials amounts to 5,689 or 179 less than last year.

405. The result of the profit and loss account of the workshop shows a nominal profit of ₹3,052, from which it appears that the rates of work are fairly correct.

406. Arrangements have been made this year with the Director General of Stores, India Office, by which instead of a very large indent for supplies being sent in long in advance, indents will in future be submitted periodically throughout the year as it becomes apparent that instruments will be required, and it is hoped in this way to avoid unnecessary accumulation of instruments.

407. A large number of theodolites of obsolete patterns which it would have been useless to attempt to convert, were with the sanction of the Government of India broken up and their materials used for the manufacture and repair of other instruments, it having been found by experience that the value of the materials to this office is greater than the amount realised by the sale of the instruments themselves in the market.

408. During the coming year a scheme for the reorganisation of the workshops, as far as possible abolishing monthly wages, is to be laid before Government, by which it is hoped that very much more work will be done, the repairable stock gradually reduced to very small dimensions and at the same time the expenditure reduced.

409. The price of instruments in store having been revised, a new catalogue will issue shortly, and the stock in hand will be re-valued in accordance with this list. This has become necessary owing to the great reduction in original cost of many instruments, and to the rise in exchange since many of the instruments in stock were purchased. In many cases it is found that perfectly new instruments can be supplied at much cheaper rates than second-hand ones of exactly similar types.

410. The amalgamation of the clerical establishment with that of the other offices has worked most favourably to this office.*

* The workshops have been ably and energetically supervised by Mr. Theakston assisted by Messrs. Ferrier and Campagnac, and the remainder of the office establishment have performed their duties satisfactorily.

II.—TRIGONOMETRICAL BRANCH OFFICE, DEHRA DÚN.

411. On 1st October 1899 Colonel St. G. C. Gore, R.E., became Surveyor-General of India and Major Burrard was appointed Superintendent of Trigonometrical Surveys, but as he was absent on deputation to Chatham, Mr. Eccles was appointed to officiate for him, and held charge of the office until relieved by Major Burrard on the 12th January 1900. During this time Mr. McA'Fee held charge of the Computing Party.

Lieut. Daunt reverted to the Military Department on the 15th November 1899. Lieutenants Gunter, Rich, and Crookshank, having completed their course were posted to field parties in November 1899 and Lieutenants McHarg, Tandy, and Hirst, on appointment to the department, were attached to this office for a course of technical training. In July 1900 the services of Lieutenants McHarg and Tandy were placed at the disposal of the Government of Bombay for famine duty, and Lieutenant Hirst completed his course and was posted to No. 4 Party at the end of the year. On 25th October 1899 Mr. McA'Fee proceeded to Delhi to assist the Austrian expedition for observing the meteoric shower of 14th November 1899, and he returned in the first week of the following month.

Mr. Christie proceeded on furlough on 7th April, and retired on superannuation pension on 29th September 1900; Mr. Hickie was transferred to this office from No. 24 Party to fill his place.

The two officers of the department of the Quarter-Master General in India who were temporarily attached to this office last year for instruction in exploration work, left after finishing their course.

Personnel.

Superintendence.

Major S. G. Burrard, R.E., Superintendent, Trigonometrical Surveys, from 12th January 1900.
Mr. J. Eccles, M. A., Superintendent, 2nd grade, Officiating Superintendent, Trigonometrical Surveys, up to 11th January, and in charge Computing Party, from 12th January 1900.
Mr. C. H. McA'Fee, Extra Assistant Superintendent, 1st grade, in charge Computing Party, up to 11th January 1900.

Attached Officers.

Lieut. B. R. Daunt, I.S.C., Assistant Superintendent, 2nd grade, up to 14th November 1899.
Lieut. C. P. Gunter, R.E., " " " up to 9th November 1899.
Lieut. E. T. Rich, R.E., " " " up to 28th November 1899.
Lieut. A. A. Crookshank, R.E., " " " up to 14th November 1899.
Lieut. A. A. McHarg, R.E., " " " from 9th January to 17th July 1900.
Lieut. M. O'C. Tandy, R.E., " " " from 17th January to 18th July 1900.
Lieut. F. C. Hirst, I.S.C., " " " from 27th January 1900.

(1) *Computing Section.*

Mr. A. D. L. Christie, Extra Assistant Superintendent, 1st grade.
" J. Hickie, " " " 4th " from 17th April 1900.
Munshi Aulad Hossein, Sub- " " 1st "
Babu Amba Prasad and 8 other Computers, 2 Copyists and 2 Clerks.

(2) *Printing Section.*

11 Press Assistants and 2 Distributors.

(3) *Photozincographic Section.*

Mr. G. A. LeFranc, Assistant.
13 Sub-Assistants, 16 Press Assistants and 3 Clerks.

(4) *Correspondence Section.*

Mr. J. Burbridge, Head Clerk, and 3 other Clerks.

(5) *Stores, Workshops and Observatories Section.*

1 Clerk, 1 Head Artificer and 3 Artificers.

(6) *Drawing Section.*

Mr. C. H. McA'Fee, Extra Assistant Superintendent, 1st grade.
Mr. J. A. Higgs, " " " 6th "
15 Draftsmen and 2 Surveyors.

(7) *Solar Photographic Section.*

Mr. R. W. Foster, Assistant Solar Photographer (*sub. pro-tem.*)

(8) *Training School.*

Mr. W. A. Fielding, Extra Assistant Superintendent, 5th grade, in charge.
Babu Himansu Kumar Roy, Sub- " " 3rd "
Messrs. J. C. C. Lears, J. H. Williams, O. J. H. Hart, Babu Maya Das Puri, Messrs. E. Claudius, H. B. Simons and O. E. C. Judd, Probationary Sub-Assistant Superintendents.
1 Surveyor, 1 Sub-Surveyor and 17 Probationary Sub-Surveyors.

412. Experiments were made with a Bridges-Lee's phototheodolite with a view to testing the system of photographic surveying. The conclusion arrived at was that the method is a sound one but though at times it might prove of great assistance to the plane-tabler, it is not likely to supersede plane-tabling in this country.

One of Troughton and Simms' tacheometers was tested and will probably prove useful for traversing in hilly ground.

The Jaderin Base-Line apparatus was used to measure the Dehra Dún Base-Line but the result is not yet known, as the computation was made with erroneous values of the coefficients of expansion of the wires, as has been explained at para. 328.

A series of observations is being made to test the expansion of a levelling staff due to humidity and temperature.

A direct process of printing from a negative on to the zinc plate has been successfully tried and will be adopted for suitable subjects.

413. The office is divided into the following sections :—

(1) Computing.
(2) Printing.
(3) Photozincographic.
(4) Correspondence.
(5) Stores, Workshops, and Observatories.
(6) Drawing.
(7) Solar Photographic.
(8) Training School.

Computing Section.—Three instalments of field records were received during the year and stored as usual. In all fourteen requisitions for data and sixty-three indents for forms were complied with. The reduction of the observations taken by Captain Deasy in his explorations in Tibet, which entailed heavy computations, was finished. The examination of the four charts of the Great Arc Meridional Series, section 8° to 18°, was finished, and they were sent to press. The adjustment of the spirit-levelled heights from Biláspur to Katni, Katni to Allahabad, and Katni to Sironj was begun and nearly finished. The selection of secondary points, for computation, of the North-East Longitudinal Series was finished, and the examination of angle books, adjustment of triangles and computations of latitude, longitude and azimuths are in progress. Meteorological and magnetic observations were continued as usual.

Printing Section.—The following is the progress made :—

(*a*) Tidal Volume—11 pages printed.
(*b*) Longitude Volume—45 pages printed.
(*c*) Spirit-levelled heights, Sections Vizagapatam to Raipur, and Raipur to Biláspur—44 pages printed.
(*d*) Professional Papers—5 pages of the revised Paper No. 1 were printed, and this as well as No. 2 were completed and issued. Of No. 3 "Method of Measuring Geodetic Bases by means of Colby's Compensation Bars," 27 pages were printed, and the paper is almost ready for issue.

In addition to the above, a large amount of work was done in printing the letter-press for charts, headings and foot-notes for maps, and about 50,000 copies of professional and other forms.

Photozincographic Section.—The usual routine of map publication was carried on. The greater part of the work consisted of reproduction of maps of the Forest department and standard maps.

Correspondence Section.—This has been conducted as usual.

Stores, Workshops, and Observatories Section.—This section has been carried on as usual. In the observatories, time observations were taken and the chronometers rated and kept in order.

Drawing Section.—Captain Deasy's Explorations in Western China and Tibet were drawn and published, and two sheets of the map of "India and adjacent countries" were begun. The map of the routes beyond the British frontier being out of date a new edition has been put in hand. The Sind Survey sheets mapped by Nos. 12 and 15 Parties were combined with those of the

Indus Riverain Survey of 1893—95, and the Punjab Survey sheets on the 4-inch scale were prepared for reduction to half scale. The charts of the Great Arc Meridional Series, section 8° to 18° and the Indus Delta Triangulation were completed and sent to press.

Solar Photographic Section.—The work of this section was conducted as usual. The use of dry plates for the greater part of the work was continued during the year and very satisfactory results were obtained.

Training School.—Instruction was continued in traversing, and triangulation with the theodolite, and in levelling, plane-tabling, fair mapping, projection, plotting and the computations of the Topographical Branch. One Sub-Assistant Superintendent, 7 newly appointed Probationary Sub-Assistant Superintendents and 17 Probationary Sub-Surveyors were put through the school course. Besides the above, three officers of the Imperial service were instructed in practical plane-tabling; and one sub-surveyor of No. 15 Party received special instruction in triangulation with the theodolite.

The offices were inspected by the Surveyor-General in October 1899 and April and July 1900, and he was quite satisfied with the working of the several sections.*

III.—NORTH-WESTERN FRONTIER DRAWING OFFICE.

414. The charge of this office was held throughout the year by Colonel Wahab, except during the period from 13th November 1899 to 9th April 1900, when, owing to his absence in the field with No. 15 Party, it devolved on Mr. Cornelius.

Personnel.

Colonel R. A. Wahab, C.I.E., R.E., Superintendent, 1st grade.
Mr. W. J. Cornelius, Extra Assistant Superintendent, 3rd grade.
Mr. R. R. Dickinson, Extra Assistant Superintendent, 5th grade.
Mr. F. E. Warde, Sub-Assistant Superintendent, 1st grade.
Mr. F. Rozario, Surveyor.
„ H. Sindon, Draftsman.
Munshi Nur Baksh, „
and 3 Draftsmen and 1 Writer.

415. The outturn of work includes the preparation of seven sheets on the $\frac{1}{8}$-inch scale of the North-Western and Northern Frontier series. New editions of 9 sheets on the $\frac{1}{4}$-inch scale have been sent in, containing the results of the recent surveys on the Perso-Balúch border by Mr. G. P. Tate, and three sheets on the $\frac{1}{8}$-inch scale have been compiled, thus bringing up to date all the sheets of that series included in British Balúchistán. The north-east section of the 16-mile map of Afghánistán, mentioned in last report as still incomplete, has also been sent in for publication.

416. Corrections and additions have been made to two of the 1-inch Punjab Survey sheets containing new material on the borders of the Pesháwar and Kohát districts not hitherto published on that scale, and a new edition of sheet No. 27^{A} on the same scale, is in hand.

417. Two sheets Nos. 34 and 35 of the new map of India and adjacent countries on the scale of $\frac{1}{1,000,000}$ have been commenced, and as the more urgent work of correcting the sheets on larger scales is completed, more rapid progress will be made with this series, which will eventually supersede the special maps on the 16-mile scale of Afghánistán, Balúchistán and Persia. Considerable progress has also been made in the compilation of data of trans-frontier triangulation, and five charts have been prepared shewing the co-ordinates of all stations and points falling in them.†

* Mr. Eccles reports very highly of the work done by his assistants, Messrs. McA'Fee, Christie, Hickie, Higgs, LeFranc and Foster, and speaks well of the computers, draftsmen and clerks.
The Superintendent reports very favourably of the assistance rendered him by Messrs. McA'Fee, Christie and Hickie; also of the services rendered by Mr. Burbridge, the Head Clerk, and Babu Hira Singh, the Second Clerk of his office. He also expresses his satisfaction with the work done by Mr. Fielding, and Munshis Muhammad Zakaria and Zakiruddin, Instructors of the training school.

† Messrs. Cornelius and Dickinson have worked zealously, and Messrs. Rozario, Sindon, and Nur Baksh deserve commendation.

IV.—FOREST SURVEY BRANCH OFFICE, DEHRA DÚN.

418. The head-quarters offices at Dehra Dún were, as usual, under the supervision of Mr. Reynolds, and the following branches of work were dealt with :—

i. Correspondence and accounts.
ii. Computations and areas.
iii. Up-keep of the map records of the Forest Department.
iv. Compilation and drawing of special maps for the Forest Department.
v. Mapping of current season's work.
vi. Training of surveyors.
vii. Other miscellaneous work for the Forest Department.

The up-keep of the map records of the forests in the several provinces under the Government of India, as well as of Bombay and Madras, have received attention. The alterations in forest boundaries and areas afforested and disforested, as notified from time to time in the provincial gazettes, have been recorded on the best available maps. Reference has already been made in previous reports to this important branch of the work which tends to increase from year to year owing to the new areas which are being constantly brought under the Forest Department, specially in Madras and Burma, and to constant changes in existing boundaries due to new and revised settlements. As usual, a large amount of miscellaneous work was done in the head-quarters offices. Under this head may be noted the colouring of 2,652 printed maps, the preparation of 365 tracings for forest and district officers and the mounting of 1,852 maps.*

419. The following abstract shows the progress made in map-drawing during the year :—

Name.	Province.	No. of Sheets.			Remarks.
		Published during the year.	At Press.	In different stages of progress.	
Special maps on various scales chiefly for Forest working-plans.	Punjab	1	...	...	
	Berar	...	2	...	
	Central Provinces	1	...	...	
	Burma	4	3	1	
Other special maps on various scales for use of Forest Department.	North-Western Provinces and Oudh	1	...	...	
	Bengal	2	...	...	
	Assam	1	...	...	
	Punjab	1	...	5	
	Berar	10	7	...	
	Central Provinces	2	...	...	
	Coorg	1	...	...	
	Madras	1	...	...	
	India.	1	...	...	
4-inch standard sheets of reserved Forests.	North-Western Provinces and Oudh	24	9	20	
	Punjab	5	13	23	
	Central Provinces	78	26	200	
	Bengal	...	...	5	
	Burma	19	74 (*a*)	41	(*a*) One on 8-inch scale.
1-inch standard sheets of reserved Forests.	Punjab	3	1	4	
	Total	155	135	299	

* Mr. Descubes, who was employed throughout the year at the head-quarters office, worked in an energetic and systematic manner and turned out a large quantity of excellent work : Mr. Reynolds desired that his high appreciation of Mr. Descubes' services should be placed on record.

Mr. Watson did good work in the Drawing Office.

Babu Badri Dutt as a computer and Tulsi Ram as a draftsman are commended for their work.

The clerical establishment under Babu Kali Kanth Kar, Head Clerk, carried on the office work in a satisfactory manner.

List of Maps and Charts published during 1899-1900.

Title.	Scale.	Number of Sheets.	Remarks.
Atlas of India.	In M.		
Sheets Nos. 27 N.E., 37 N.W., and 76 S.W.	1=4	3	
„ Nos. 31 S.E., 31 S.W., 87 N.W., and 127 N.E.	„	4	With additions to 1898.
„ Nos. 52 N.E., 59 S.W., 64 S.W., 70 S.E., 71 S.W., 125 S.E., and 131 N.W.	„	7	Ditto 1899.
„ No. 77 N.E.	„	1	Ditto 1891.
„ No. 17	„	1	Ditto 1898.
„ No. 40	„	1	Ditto 1896.
„ No. 44	„	1	Ditto 1897.
„ Nos. 54 and 61	„	2	Ditto 1899.
„ No. 80	„	1	Ditto 1900.
„ No. 106	„	1	Ditto Sept. 1898.
General Maps.			
India	1=128	1	With hills. Engraved. With additions to Railways to 1898.
India	1=96	1	Skeleton. With additions and corrections to Railways to 1898.
India	1=64	2	Skeleton.
Portions of Western China and Tibet explored by Captain H. H. P. Deasy in 1897-1899	1=8	5	
Provincial Maps.			
Assam	1=32	1	
North-Western Provinces and Oudh	1=32	1	With additions to June 1899.
Punjab and surrounding countries	1=32	1	Skeleton. With additions and corrections to Railways and boundaries to September 1899.
Central India Agency	1=16	2	With additions and corrections to 1899.
Sind	1=16	1	With additions to 1900.
Eastern Bengal, Sheet No. 13	1=8	1	With additions and corrections to Railways and boundaries to 1899.
Western Bengal, Sheet No. 8	1=8	1	Ditto ditto to 1899.
District Maps.			
Káthiáwár	1=16	1	
Darrang	1=4	1	
Hoshangabad	1=4	1	With additions and corrections to boundaries, etc., up to May 1899.
Midnapore	1=4	1	With additions and corrections to 1899.
Mymensingh	1=4	1	Ditto ditto to January 1900.
Peshâwar	1=4	1	Ditto ditto to 1899.

Title.	Scale.	Number of Sheets.	Remarks.
Standard Maps.			
Assam.	In. M.		
Sheet No. 162	1=1	1	
Bengal.			
Sheets Nos. 138 and 169	1=1	2	
Bombay.			
Sheet No. 164	1=1	1	Corrected to May 1897.
„ No 206	1=1	1	With additions and corrections to April 1898.
Burma (Lower).			
Sheets Nos. (276 $\frac{N.E.}{4}$ and part of 323 $\frac{N.W.}{3}$) in one	4=1	1	
Burma (Upper).			
Sheets Nos. 174, 175, 304, 305, 307, 350, 351, 398, 401, 402, 403, 406 and 458	1=1	13	Preliminary editions.
„ No. 312	1=1	1	2nd edition.
„ No. 405	1=1	1	
Central India and Rájputána.			
Sheet No. 205	1=1	1	With additions to Roads and Railways to May 1891.
„ Nos. 210, 410, and 420	1=1	3	
„ No. 282	1=1	1	Boundary corrected to 1888.
„ Nos. 274 and 471	1=1	2	With additions to Railways to 1899.
Central Provinces.			
Sheets Nos. 8, 18, 22, 28 and 68	1=1	5	
Hyderabad.			
Sheet No. 110	1=1	1	
North-Western Provinces and Oudh.			
Sheet No. 15	1=1	1	With additions to village boundaries, etc., up to September 1898.
„ Nos. 63 $\frac{S.E.}{3}$; 64 $\frac{N.E.}{1}$; 64 $\frac{N.E.}{2}$; 64 $\frac{N.E.}{3}$; 251 $\frac{N.W.}{4}$; 251 $\frac{N.W.}{2}$; 251 $\frac{N.W.}{3}$ and 251 $\frac{N.W.}{4}$	4=1	8	With additions and corrections to November 1898.
„ No. 64 $\frac{N.E.}{4}$	4=1	1	With corrections to June 1897.
Punjab.			
Sheet No. 82	1=1	1	
„ Nos. 66 S.E., 67 S.E., 68 S.E., 68 N.E., 69 N.E., 69 N.W., 69 S.E., 69 S.W., 70 N.E., 70 N.W., 93 S.E., 93 S.W., 94 N.E., 94 N.W., 94 S.E., 94 S.W., 95 N.W., 121 S.E., 121 S.W., 122 N.E., 122 S.W., 264 S.E., 264 S.W., 307 S.W., 308 N.W., and 311 S.E.	2=1	26	

Title.	Scale.	Number of Sheets.	Remarks.
Standard Maps—*continued.*	In. M.		
Sheets Nos. 247 $\frac{\text{N.E.}}{1}$; 247 $\frac{\text{N.E.}}{3}$; 247 $\frac{\text{N.E.}}{4}$; 247 $\frac{\text{N.W.}}{2}$; 247 $\frac{\text{S.E.}}{1}$; 247 $\frac{\text{S.E.}}{2}$; 247 $\frac{\text{S.E.}}{3}$; 247 $\frac{\text{S.E.}}{4}$; 263 $\frac{\text{N.E.}}{3}$; 263 $\frac{\text{S.W.}}{3}$; (306 $\frac{\text{N.E.}}{3}$ and 306 $\frac{\text{S.E.}}{1}$) in one; 306 $\frac{\text{N.W.}}{3\&4}$; 307 $\frac{\text{S.E.}}{1}$; 307 $\frac{\text{S.E.}}{3}$; 308 $\frac{\text{N.E.}}{1}$; 308 $\frac{\text{N.E.}}{2}$; 308 $\frac{\text{N.E.}}{3}$; 308 $\frac{\text{S.E.}}{2}$; 308 $\frac{\text{S.E.}}{4}$; 309 $\frac{\text{N.E.}}{2}$; 313 $\frac{\text{N.E.}}{3}$; 313 $\frac{\text{N.E.}}{4}$; 313 $\frac{\text{N.W.}}{2}$ (*a*); 313 $\frac{\text{N.W.}}{4}$ (*a*); 313 $\frac{\text{S.E.}}{4}$; 313 $\frac{\text{S.W.}}{2}$ (*a*); 313 $\frac{\text{S.W.}}{4}$ (*a*); 314 $\frac{\text{N.E.}}{4}$; (335 $\frac{\text{S.E.}}{3}$ and 335 $\frac{\text{S.E.}}{1}$) in one, 335 $\frac{\text{S.W.}}{1}$; and 336 $\frac{\text{N.E.}}{1}$	4=1	31	(*a*) 2nd editions.
Sind.			
Sheets Nos. 47, 48, 49, 68, 69, and 88	1=1	6	
„ No. 69 N.E., 69 N.W.; 69 S.E. and 69 S.W. . .	2=1	4	
North-Eastern Frontier.			
Sheet No. 22	1=8	1	6th edition.
„ No. 13 (South Sylhet)	2=1	1	With addition to Roads, etc., to June 1899.
South-Eastern Frontier.			
Sheet No. 7	1=8	1	2nd edition, with additions and corrections to boundaries to 1899.
Sheet No. 1 N.E.	1=4	1	7th edition.
North-Western Frontier.			
Sheet No. 12 (Hazára)	1=1	1	With addition of village boundaries.
Plans of Cities and Cantonments.			
Calcutta, Sheet No. M 17	1=5oft.	1	2nd edition corrected to November 1899.
„ Sheet No. N 18	1=5oft.	1	Corrected to February 1899.
„ Sheets Nos. N 15, N. 19, N. 23, O 22 and O 23 .	1=5oft.	5	Do. to April 1899.
„ Sheets Nos. P. 21 and P. 23	1=5oft	2	Do. to March 1899.
Quetta Cantonment	In. M. 16=1	4	2nd edition revised to 1898.
Simla and Jutogh	6=1	1	With additions and corrections to July 1899.
Administration Report Maps.			
Punjab	1=80	1	With additions to 1899.
Assam	1=48	1	2nd edition.
Berar	1=24	1	Engraved. Skeleton. With additions to 1896.
Berar	1=24	1	Engraved. With hills. With additions to 1896.
Simla	1=16	1	Engraved. Without hills.
Akola	1=8	1	
Bareilly	1=8	1	Engraved. Corrected to 1900.
Chhindwára	1=8	1	Engraved. With hills.
Jhelum	1=8	1	Engraved.
Nimár	1=8	1	Corrected to August 1899.
Purnea, Rohtak, Tippera and Hill Tippera . . .	1=8	4	Do. to 1899. Engraved.

Title.	Scale.	Number of Sheets.	Remarks.
	In. M.		
Index Maps.			
Assam, showing scales of survey	Various	1	Corrected to 1898-99.
" " " of publications	...	1	
Bengal " " of old survey	...	1	Do. to 1899.
" " " of new survey	...	1	Ditto.
" " " of publication	...	1	Ditto.
North-Western Provinces and Oudh, showing scales of old survey	...	1	Ditto.
" " " " " of new survey	...	1	Ditto.
" " " " " of publications	...	1	Ditto.
Punjab, showing surveys by the Forest Department	...	1	Do. to 1898-99.
India and adjacent countries	1=256	1	
Statistical Maps.			
India, to illustrate gauges of Railways	1=80	1	Corrected to 30th September 1899.
" " " " "	1=80	1	Do. to 31st March 1900.
Miscellaneous.			
Alwar State	1=4	1	
Burma-China Boundary Commission, Southern Party	1=4	1	Reconnaissance map.
Conventional signs for Cadastral maps on 16 and 32-inch scales	...	1	
Conventional signs and terms used in Military Topography	...	1	
Plan of His Excellency the Viceroy's Stables, Dehra-Dun	48=1	1	
Specimen plane-table	4=1	1	
Charts.			
Triangulation and Traverse of sheet No. 77 A. (Sind)	1=2	1	
Nos. 6 and 7, Preliminary Charts of the Principal Triangulation of the Manipur Longitudinal Series, Seasons 1894-1896 and 1898-1899	1=4	2	
Nos. 1 and 2 Makrán Longitudinal Series	1=1	2	

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Title of Map.	Scale.	Number of sheets.
	In. M.	
STANDARD MAPS - contd.		
Central Provinces—contd.		
Seoni Forest Survey—Sheets Nos. 71 N. E./4; 89 S. E./4; 90 N. W./2; 90 N. W./4; 90 N. E./1; 90 N. E./2; 90 N. E./4 and 112 N. W./3 (in one); 90 S. E./2; 91 N. W./1; 92 N. W./4; 112 N. W./1; and 112 S. W./1	4=1	12
North-Western Provinces and Oudh.		
Bahraich Forest Survey—Sheets Nos. 129 S. W./2; 129 S. W./4; 129 S. E./1; 129 S. E./3; 130 N. W./2; 130 N. W./4; 130 N. E./4 and 144 N. W./3 (in one); 130 S. E./1; 130 S. E./2; 130 S. E./4; 131 N. E./2; 131 N. E./4; 144 S. W./1; and 145 N. W./2 & 4 (2nd Edition)	4=1	14
Kheri Forest Survey—Sheets Nos. 113 N. W./3 and N. W./1 (in one); 113 N. W./4 and N. W./2 (in one); 113 S. W./1; 113 S. W./2; 113 S. W./3 and 114 N. W./1 (in one) (2nd Edition); 113 S. E./1; 113 S. E./3; 113 S. E./4; 114 N. E./2; 114 N. E./4 (2nd Edition); 114 S. E./1 (2nd Edition); and 114 S. E./2 & 4 (2nd Edition)	4=1	12
Punjab.		
Bashahr Forest Survey—Sheets Nos. 333 N. W./4 and S. W./2 (in one); 348 N. W./4; and 352 N. W./3	4=1	3
Chamba Forest Survey—Sheets Nos. 244A N. E./3 & 4; and 262C S. W./1 & 3 and 245 S. E./4 (in one)	4=1	2
Sheets Nos. 245, 246, and 262C	1=1	3
Index Maps.		
Index to Forest Surveys in Pegu and Tenasserim, Burma	1=32	1
" " Forest Surveys in the Chamba State 1898-99	1=8	1
" " Forest Surveys in the Sambalpur District, Central Provinces . . .	1=8	1
" " Map of the Malay Peninsula	1=20	1
Charts.		
Punjab—Sheet No. 263, (Chamba State)	1=2	1
Miscellaneous.		
Punjab—Showing distribution of Forest Areas, 1898-99	1=32	1
Berar or the Assigned Districts—Showing distribution of Forest Areas 1898-99 .	1=8	1
Bengal—Showing the distribution of Forest Areas 1898-99	1=32	1
Assam—Showing distribution of reserved forests on 30th June 1899	1=32	1
North-Western Provinces and Oudh—Showing distribution of Forest Areas 1898-99	1=32	1
Coorg—Showing the distribution of Forest Areas up to 30th June 1899 . . .	1=4	1
Central Provinces—Showing the distribution of Forest Areas up to 30th June 1899 .	1=32	1
Madras—Showing the distribution of Forest Areas up to 1898-99	1=32	1
Hyderabad, Assigned Districts or Berar, Chándur Táluk, Amráoti District .	1=1	3
" " " " Kelapur Táluk, Wún District . .	1=1	3
" " " " Básim Táluk, Básim District . .	1=1	3
Burma Forest Survey—Part of Pakôkku District Tazan Exclusions . . .	4=1	1
" " " " Yaw Division	4=1	1
" " " " Yaw Division, Thongyauk Reserve	4=1	1
Ráwalpindi Forest Survey—Sketch Map of Kahuta and Murree Forests showing working Circles and Compartments	1=2	1
Stock Map of Wairagarh, Ghote and Dhaba Ranges, Chánda District . . .	1=4	1
Pyinmana Forest Survey, Yeni Reserve, Yeni Working Circle	1=1	1

TITLE OF MAP.	Scale.	Number of sheets.
	In. M.	
STANDARD MAPS.		
BURMA.		
Ataran District—Sheets Nos. 478 S. W./4; 479 N. W./1 and 478 S. W./3 (in one); 479 N. W./2; 479 N. W./3; 479 S. W./2; 479 S. E./2; 479 S. E./3; and 480 N. W./2 and N. E./1 (in one)	4=1	8
Pegu District—Sheets Nos. 276 S. E./4; 277 N. E./1; 277 S. W./1; 277 S. W./2; 277 S. W./4; and 324 N. W./1	4=1	6
Pegu and Tharrawaddy Districts—Sheet No. 277 N. W./3	4=1	1
Pyinmana District—Sheet No. 269 N. W./3	4=1	1
Thayetmyo District—Sheets Nos. 224 N. W./1, 2, 3 and 4; 225 N. E./2; and 225 N. E./3.	4=1	3
BENGAL.		
Singhbhum Forest Survey—Sheet No. 126	1=1	1
CENTRAL PROVINCES.		
Bálaghát Forest Survey—Sheets Nos. 113 N. E./1; 113 N. E./3; and 136 N. W./4.	4=1	3
Chhindwára Forest Survey—Sheets Nos. 37 N. E./2; 53 N. W./3; 53 N. E./1; 53 S. W./1; 53 S. W./3; 53 S. E./2; 53 S. E./4; and 71 S. W./3 . .	4=1	8
Nágpur-Wardha Forest Survey—Sheets Nos. 39 S. W./2 & 4 and 40 N. W./2 (in one); 39 S. E./3 and S. E./1 (in one); 39 S. E./4 and S. E./2 (in one); 40 N. E./1 and N. W./2 (in one); 40 N. E./2; 40 N. E./3 and N. W./4 (in one); 40 S. E./1; 40 S. E./2; 40 S. E./3; 40 S. E./4; 41 N. E./2; 41 N. E./4; 54 S. E./4 & 2; 55 N. W./2 & 4; 55 N. E./1; 55 S. W./3; 55 S. E./3; 56 N. W./1; 56 N. W./2; 56 N. W./3; 56 N. W./4; 56 N. E./1 and N. E./2 (in one); 56 N. E./3; 56 N. E./4; 56 S. W./1; 56 S. W./3; 57 N. W./1; 73 S. E./2; 75 N. E./1 and N. E./3 (in one); 75 N. E./4; 75 S. W./1 and S. W./3 (in one); 75 S. W./2; 75 S. W./4; 75 S. E./1; 75 S. E./2 and 95 S. W./1 (in one); 75 S. E./3; 75 S. E./4; 76 N. W./1 & 3; 76 N. W./2; 76 N. W./4; 76 N. E./1; 76 N. E./2 & 4; 76 N. E./3; 76 S. W./2; and 76 S. W./4 and 77 N. W./2 (in one) . .	4=1	45
Raipur Forest Survey—Sheets Nos. 204 S. E./3 and S. E./1 (in one); 204 S. E./4 and S. E./2 (in one); 205 N. E./1; 205 S. W./2; 205 S. E./1; and 223 S. W./3	4=1	6
Saugor Forest Survey—Sheets Nos. 30 N. W./2; 32 N. E./1; 32 N. E./2 and 46 N. W./1 (in one); 45 N. W./1; 45 N. W./4; 45 N. E./1; 45 N. E./2 and 44 S. E./3 & 4 (in one); 45 S. W./1; 45 S. W./3; 45 S. W./4; 45 S. E./3; 46 N. W./2; 46 N. W./3; 46 N. W./4; 46 S. W./1; and 46 S. W./2 . .	4=1	16

APPENDIX.

Note on the present state of the Topographical Maps of India by COLONEL St. G. C. GORE, R.E., *Surveyor-General of India.*

The following note has been drawn up to show the present state of the topographical maps throughout India.

It will be seen that by far the larger number of the existing sheets are compiled from very old surveys, many of them from 40 to 60 years old, and are now hopelessly out of date not only as regards villages and their boundaries, but also as to streams, rivers, roads and railways.

It must be remembered, however, that the newer topographical maps, which are mainly being compiled from cadastral and settlement surveys, will quickly fall into arrear unless some systematic method of periodical revision is undertaken.

I propose now to deal shortly with the state of the standard maps in each Province.

BENGAL.

Old Surveys.

The old Bengal surveys, on which until very lately we have had to depend for our maps, were commenced in 1834 and were nearly all completed by 1865. The method of survey adopted was to make village maps at first village by village and subsequently in groups, on the scale of 4 inches = 1 mile. These were surveyed by Revenue survey parties and, as is necessarily the case in flat cultivated ground, were entirely based on traverses, no triangulation being executed, but stations of the Great Trigonometrical Survey being connected where possible.

The only exceptions to this method of survey were as follows :—

(1) In the Hazáribágh, Singhbhum, Ranchi and Garhját State districts of Chota Nágpur, where topographical surveys on the scale of 1 inch = 1 mile were carried on between 1856 and 1872.

(2) In the Tributary Mahals of Orissa a topographical survey was made between 1850 and 1863, on the scale of 1 inch = 2 miles.

(3) In the Chittagong Hill Tracts and in Hill Tippera a rough reconnaissance on the 1-inch scale was carried on by a Revenue survey party.

With reference to the quality of all these surveys, the 4-inch Revenue surveys answered their purpose well from a fiscal point of view, as the boundaries of villages were accurately shown, the periphery of all villages being traversed. In the matter of interior details such as roads, streams, etc., they, however, left much to be desired. They were executed in the early dawn of Indian topography by natives who had only been trained to survey boundaries, with the result that much faulty work was shown in the interior of villages.

The Chota Nágpur topographical survey was based on triangulation and is a fair specimen of the topography of those days. No village boundaries were shown.

In the reconnaissance of Hill Tippera and the Chittagong Hill Tracts the work is of the roughest, the large streams having been traversed with compass and chain and some of the main ridges sketched in.

Old Maps.

So much for the original surveys of Bengal. As regards the publication of the maps no attempt was ever made to publish the 4-inch village maps on the original scale of survey. They were reduced to the scale of 1 inch = 1 mile and published in various forms, the earliest ones in groups of villages, as they fell within the limits of each main circuit traverse, next with the villages filled in to the margins of each sheet (congregated maps); later on the sheets were published completed up to even lines of latitude and longitude and finally about 1872 the present method of publishing in standard sheets, each embracing 15 minutes of latitude and 30 minutes of longitude was adopted. In this form were also published the topographical survey sheets of Chota Nágpur.

The reconnaissance of the Chittagong Hill Tracts and Hill Tippera was reduced and published on the ½-inch scale.

From the time of the original surveys no steps whatever have been taken for their revision. From time to time a certain number of those which had been published in the most inconvenient form were redrawn in modern standard sheet shape, their names and style of drawing being modernised, but the detail is that of 50 or 60 years ago.

Modern Surveys and Maps.

We now turn to modern surveys and maps. With the exception of a few small areas surveyed for irrigation purposes and one or two riverain surveys, nothing was done to mend matters until cadastral surveys were undertaken. These were commenced in about 1886 and since then the following districts have been surveyed :—

Cuttack.	Balasore.
Puri.	Muzaffarpur.
Sáran.	Champáran.
Darbhanga.	Chittagong.

In addition to these districts a number of small estates in various parts of the province have been cadastrally surveyed.

Other districts in Bengal are gradually coming under cadastral survey, but, owing to the nature of the land settlements in this province, it is certain that further progress in this direction will be slow and it seems unlikely that all the remaining districts, should their survey be undertaken, can be completed in less than 20 or 25 years.

All these cadastral surveys are being utilised to bring the topographical maps up to date. New 1-inch standard sheets are being compiled from reductions of them wherever the area surveyed is sufficient to justify the work being undertaken.

In a flat country like Bengal where natural topographical detail is, with the exception of rivers and streams, comparatively scarce and where the military importance of the country is small, such reduced cadastral surveys make very fair topographical maps, but in other parts of India where those conditions do not prevail, it has been well proved that topographical maps so compiled must be examined in the field before publication and the topography added to and corrected where necessary. the chief items for which additional work is required being generally found to be hilly ground, ravines or broken ground, banks of streams and the true shapes of village sites.

An examination of the standard sheets compiled from these new cadastral surveys at once showed that the old 1-inch maps compiled from the original surveys of 40 or 50 years ago were absolutely useless for any practical purpose, and the question has therefore arisen whether, pending the many years which must elaspe before cadastral surveys can be carried on over all the districts in Bengal, any thing can be done to bring the old maps sufficiently up to date to render them serviceable. In order to attempt this it is necessary that the surveyors should be able to identify on the ground a number of points shown on the maps in order to afford starting points for the revisionary work. For such fixed points one naturally looks to the trijunction points of villages, but unfortunately enquiries instituted show that in Bengal, except in the ground which has lately come under cadastral survey, these trijunctions are not marked. This puts any attempt to revise the old 1-inch maps quite out of the question, and short of a new topographical survey, there is nothing but to wait patiently till cadastral surveys push their way slowly over the country.

It must be borne in mind, however, that these newly compiled topographical maps will surely fall into arrear and become obsolete unless some systematic method of keeping them up to date by revision is quickly set on foot.

Whatever scheme may be instituted for this revision, one point is essential, that is that for the purposes of the revisionary survey it is absolutely necessary that the surveyors should be able to identify on the ground a sufficient number of points which are marked on the maps, from which to commence measurements in inserting new detail.

The only feasible way to ensure this is to put down permanent marks at village trijunctions and, by a careful system of inspection and reports, *for the local officials to see that the marks are kept up.*

Summarised, the present state of the Bengal maps is approximately as follows:—

In all there are 435 standard sheets on the 1-inch scale comprised in Bengal. Of these up to date, modern cadastral surveys have been carried over about 57 sheets in addition to a number of detached surveys which do not give sufficient material to recompile the sheets.

Some 93 sheets in Chota Nágpur were topographically surveyed between 40 and 50 years ago, and as far as the hill features go the maps are fairly good but they are hopelessly out of date as regards all fiscal detail. Of the remaining 285 sheets nothing but the old, useless, out of date maps exist.

North-Western Provinces and Oudh.

Original surveys.

The original surveys in the plains of the North-Western Provinces and Oudh consisted, as in Bengal, of village surveys on the scale of 4 inches =1 mile conducted by the Revenue Survey Department. The earlier ones date back as far as 1833 and they were practically all completed by 1870. The records of some 13 districts were lost or partially destroyed in the Mutiny, and consequently no proper maps of these districts have ever been available, the only ones existing being skelcton district maps on the half-inch scale.

Of the remainder of the districts which were surveyed by the Revenue survey, maps on the scale of 1 inch=1 mile were published, but on account of the great time which has lapsed these are all practically out of date.

More modern surveys.

Between 1868 and 1878 an excellent topographical survey of Kumaun and Garhwál was carried out and a very good series of standard maps on the scale of 1 inch=1 mile were constructed. These are gradually getting out of date, although naturally changes in hilly country are of less frequent occurrence than in the more open districts. No village boundaries were shown in these maps.

In 1873-76 a topographical map of Dehra Dún district, and the Siwálik hills was made, the Jaunsár Báwar being surveyed on the 2-inch scale, and Dehra Dún proper and the Siwáliks on the 4-inch scale. Maps were published on the scales of survey and also on the 1-inch scale. The latter were, however, not in standard sheet form.

Between the years 1882-1886 a topographical survey of the hilly portions of the Mirzapur district was made on the scale of 2 inches=1 mile, the maps being published on the 1-inch scale.

Between 1877 and 1884 a party was employed in making a topographical survey of the districts of Saharanpur, Muzaffarnagar, Meerut, Bulandshahr and Aligarh, on the scale of 2 inches=1 mile. The maps, which were very good examples of topographical maps in flat country, were published on the scale of 1 inch=1 mile. On these all village boundaries were shown.

Of these districts, that of Meerut has since come under settlement in the years 1894-97. It was found necessary to retraverse the district to enable the larger scale survey by local agency to be made. As the changes and alterations were found to be numerous it has been considered advisable to redraw the 1-inch standard sheets, incorporating the new material.

Cadastral surveys.

About 1872 the modern system of cadastral surveys for settlement purposes was commenced, and this system with various modifications has been continued till the present time. As long as such surveys are based on a scientific system of traverses, by which trijunctions of villages are properly fixed, the resulting maps can be used for compiling topographical maps and by this means standard sheets of the following districts have been prepared:—

Moradabad.	Jaunpur.
Agra.	Ballia.
Muttra.	Benares.
Bánda.	Gházipur.
Hamírpur.	Gorakhpur.
Mirzapur.	Basti.
Jhánsi.	

The drawing of the following maps is in hand:—

Lalitpur.	Bahraich.
Sháhjahánpur.	Kheri.
Meerut.	Bareilly.
Bijnor.	

As surveys are completed, data for the preparation of maps of the following districts will become available:—

Pilibhít.	Azamgarh.
Gonda.	Etáwah.
Farrukhabad.	Etah.
Mainpuri.	

Under present arrangements the Board of Revenue have accepted the local settlement maps, which have not been based on professional traverses, of the districts mentioned below—

Budaun.	Lucknow.
Fatehpur.	Bara Banki.
Cawnpore.	Fyzabad.
Allahabad.	Rae Bareli.
Hardoi.	Partábgarh.
Sitapur.	Sultánpur.
Unao.	

As regards the first four of these, none of the old traverse data remain so it is not possible in any way to utilize the settlement maps and these districts must continue to remain without topographical maps. Of the remaining nine districts constituting Oudh, though no modern traverses exist, we still have the traverses which were done at the time of the original surveys between 1860—1870. If the village boundaries have not changed much it may be possible to compile from the settlement maps on the basis of the old traverses, though it is somewhat doubtful if the resulting maps will be worth the labour spent on them.

There remains to mention the Hill Native State of Tehri Garhwál. A reconnaissance of this on the small scale of 1 inch=4 miles was made many years ago in 1851-53. This was never more than a sketch and should be superseded by a proper topographical survey on the scale of ½ inch or 1 inch=1 mile. It is a most interesting portion of the Himalayas.

PUNJAB.

Old surveys.

The Punjab consists of two widely differing classes of country, the hills and plains, and we consequently find that surveys have been made by two different agencies. The hilly portions have been surveyed as follows:—

In Kashmir and the North Western Himalayas a survey was made commencing in 1848 and being completed in 1865. In the more open part of Kashmir the scale chosen for the work was the ½-inch to 1 mile but for all the rest of the Himalayas the work, which was done on the ½-inch scale, partook much more of the nature of a reconnaissance.

In Jhelum and Rawalpindi an excellent topographical survey was executed in 1851-59 on the scale of 1 inch=1 mile which, as far as topographical features are concerned

is good enough for present requirements though, of course, it is much out of date in the matter of roads and villages and unfortunately no village boundaries are shown. This map was published by lithography but not in standard sheet form.

In Hazara between the years 1865 and 1869 a survey was carried on, the flat ground being surveyed on the scale of 4 inches=1 mile, and the hilly portion, which forms by far the greater part of the district, on the scale of 2 inches=1 mile, the resulting maps being published on the scale of 1 inch=1 mile. This survey was unfortunately made by a Revenue Survey party and although it has been based on a full system of triangulation, which ensures general accuracy of position, yet it is clear from an inspection of the maps that the surveyors had little idea of surveying hill features and it is doubtful how far the map is trustworthy in this respect. Village boundaries were surveyed on both the 4-inch and 2-inch scales but were not shown on the published maps which are, moreover, much out of date.

In Kohát a good modern topographical survey on the scale of 1 inch=1 mile was carried on in 1880-83, the maps of which, though naturally becoming out of date through lapse of time in the matter of roads, etc., are all that could be desired except that the village boundaries were not surveyed. They were unfortunately not published in standard sheet form. In Kángra, Kullu, the hilly portion of Hoshiárpur and the Simla Hill States a modern topographical survey is still in progress and is nearing completion. The scales of survey are 4 inches, 2 inches and 1 inch to a mile according to locality. The maps are being published on the scales of survey as well as on the 2-inch and 1-inch scales, and village boundaries are shown on all except the 1-inch series.

We now turn to the plains portion of the Punjab.

The basis of the older series of maps in the plains was a number of Revenue surveys on the scale of 4 inches=1 mile executed between 1846 and 1880. These surveys were published in various manners, the oldest of them being issued in the form of district maps on the scale of 1 inch=2 miles, the later ones on the scale of 1 inch=1 mile, many in standard sheet form. The only exception to this system of survey was that which was made in Hissar. In this district between 1882 and 1884 a topographical survey on the 2-inch scale was made, showing detail and village boundaries. The maps were published both on the 2-inch and 1-inch scales. The greater part of these maps may be looked on as obsolete, the more modern ones being fairly good though they badly require bringing up to date.

About the year 1880 the Punjab Government commenced a series of large scale village surveys as districts came under settlement. These maps were based on a system of survey peculiar to the Punjab, the "square" system. Arrangements were made with the Imperial Government that the Survey Department should try and utilize these village maps as a basis of new topographical maps of the Punjab.

Revision of maps from modern settlement surveys.

To this end in 1884 a survey party was told off to undertake the work. An attempt was first made to compile maps from the village maps, basing them on the traverses executed in connection with the old Revenue surveys. This method failed, as additional traversing was found to be requisite. The system finally employed was to traverse all the villages, fixing all trijunctions. The settlement maps were then reduced to the scale of 2 inches=1 mile and fitted on to the plotted positions of the trijunctions on field sheets. These sheets were then taken into the field, the work tested and any omission of topography made good. These omissions were found almost always to consist of the delineation of banks of streams or ravines, the positions of milestones and the true shapes of village sites. The remaining detail in the maps was found to be quite correct enough for the purpose, and there is no doubt, that whatever may be said against the "square" system, owing to its contravening the accepted principles of surveying, where it is confined to flat ground and when the attempt is not made to extend a single system of squares over any considerable area, the resulting maps are quite good enough, when fitted on to fixed points, to form the basis of our topographical maps.

This system continued until 1889, when the party was unfortunately withdrawn from the Punjab. It worked well and during the six years that the party was at work, standard sheets on the scale of 1 inch=1 mile were completed of the following districts:—

Jullundur.	Umballa,
Ludhiána.	Hoshiárpur (the plains portion),
Ferozepore.	Jhang.

And traverses in advance were run over seven other districts, *viz*:

Shahpur.	Siálkot.
Gujrát.	Gurdáspur.
Gujránwála.	Amritsar.
Lahore.	

Arrangements are now being made to re-establish a party in the Punjab in order to continue this system of compiling maps, and if it is carried on continuously as new settlements are made, and as the settlement maps are brought up to date, we shall eventually obtain a complete set of modern topographical maps of all the plains portion of the province.

The method unfortunately is not applicable to the more hilly portions. The system depends for its success on our being able to accept the *patwáris'* maps as sufficiently correct as regards each village boundary and the interior detail. In the hills this is not, as far as we have seen, the case; the fields in the flatter cultivated portion of the village may be fairly well surveyed but the village boundary in the hilly ground is only roughly entered, and in consequence it is impossible, when the Survey Department has fixed the positions of the village trijunctions accurately, to fit in the village maps in their correct position. The districts which come under this category are—

Hazára.	Jhelum
Kohát.	Rawalpindi.

The only method of bringing these maps up to date would seem to be to employ a revising topographical detachment, and enter the village boundaries and other topographical changes by plane-table survey.

Assam.

Revenue surveys.

The earlier surveys in Assam as in the other provinces of the Bengal Presidency were undertaken by the Revenue Survey. Surveys on the scale of 4 inches=1 mile of the cultivated portions of all districts were carried on between the years 1855—1875. The results of these surveys were published, for the greater part in standard sheet form, on the scale of 1 inch=1 mile. These maps, as far as the cultivated portions of the country are concerned, were good, though naturally the detail in the jungle portion, which has since been opened up, was not very accurate. Owing to the time which has elapsed since the country was surveyed and to the great extension of cultivation which has taken place they are now quite out of date.

Topographical surveys.

The survey of the hilly portions of the province was undertaken by the Topographical Survey from time to time. The tracts which thus first came under survey were the Gáro and Khási and Jaintia hills which were mapped between 1864 and 1879, the former being surveyed on the scale of 1 inch =1 mile, the latter on the ½-inch scale. Similar surveys on the ½-inch scale were, as opportunity arose, gradually carried over the Nága and neighbouring hill tracts on the east of Assam.

Our maps of the Manipur and Lushai country and of the various tracts along the borders inhabited by frontier tribes, which are all on the ½-inch scale, we owe to reconnaissances done at various times, frequently in connection with and in continuation of military expeditions. These topographical maps, though no doubt becoming out of date in various particulars, answer, it is believed, all present requirements.

Modern surveys and maps.

As in other provinces, the opportunity of revising the maps of Assam comes from the modern cadastral and settlement surveys. These, at first undertaken by the Survey Department, have of late years been carried on by local agency, and at present extend through the cultivated portions of the districts of Sibságar, Lakhimpur, Nowgong, Darrang, Kámrúp, Goálpára, Sylhet and Cachar. The difficulty of utilizing these large scale surveys for topographical maps is that they only deal with opened up and cultivated country and, to partially remedy this, topographical detail of the riverain tract of the Brahmaputra and some other small areas have been surveyed on the scale of 2 inches=1 mile.

When, however, all this is utilized, we have to face the fact that the new series of maps will only cover a portion of the flat country and that large gaps of forest covered and uncultivated areas will be left unmapped. These gaps may be roughly filled in from the old Revenue Survey, the detail taken from which will probably be printed in a different colour so as to distinguish it from the more accurately fixed detail taken from the large scale maps.

A small Provincial detachment of the Survey Department has been organised, which deals with the traversing of areas required for local settlement surveys and with the maintenance of records. The compilation of some of the topographical maps will also be undertaken by this detachment, and it is hoped that they will be enabled to fill in some of the smaller blanks in the topography which are inevitable when settlement surveys are used as the basis of compilation. The detachment is, however, not strong enough to undertake anything in the way of a comprehensive topographical survey of the blank portions.

A topographical survey of the Lushai Hills was commenced in 1897 and is at present being prosecuted. The scale adopted is that of 1 inch=1 mile. This work will supersede the old rough reconnaissance on the ½-inch scale which is the only thing at present in existence of that tract.

Central Provinces.

The question of the mapping of the Central Provinces presents perhaps the greatest difficulties of all the provinces. The nature of the country differs considerably from any of the provinces of the Bengal Presidency. In the Central Provinces instead of the unbroken plain covered with cultivation which is elsewhere met with we find an intricate mixture of jungle-clad hills and cultivated plains.

The nature of the country is reflected in the character of the surveys which were carried on there. Between 1861 and 1877 in this province a series of surveys were

executed of widely different character. Both Revenue and Topographical parties were employed and each surveyed the country according to its lights and training. The topographical parties working on the scale of 1 inch=1 mile made the usual topographical surveys, paying most attention to the physical features and ignoring village boundaries, while on the other hand the revenue surveyors carefully traversed the village boundaries and filled in the detail in the flat ground, on a scale of 4 inches = 1 mile but only indicated the hills in a rough and perfunctory manner. The maps resulting from these surveys were published on the scale of 1 inch =1 mile, but in various forms and neither of them meet present requirements.

Cadastral surveys.

Between 1885 and 1889 some cadastral surveys were made in the Biláspur and Raipur districts by the Survey of India Department but the work was abandoned, and a system of local settlement surveys was commenced. Some of these were based on professional traverses and others were executed wholly by local agency without any scientific basis. The cadastral surveys and the scientifically-based local surveys will both afford material for topographical maps, though nothing can be done with the non-scientific local agency maps, though perhaps if they are subsequently traversed it may be possible to enter the village boundaries from them.

Forest surveys.

In addition to the above, excellent surveys of the Government forests, which cover a considerable extent of the Central Provinces, on the scale of 4 inches=1 mile, have been carried on for some time past and are now nearly completed.

Mapping required.

The problem then is to construct the best maps possible out of this very mixed material. The cadastral and settlement surveys are dependable as far as village boundaries, village sites and roads within the village areas go, but cannot be absolutely relied on for other topographical detail such as streams and ravines and show no hills at all. The old revenue maps show some of this detail as it was 40 years ago, but are untrustworthy as regards the hills. The old topographical maps show no village boundaries or trijunctions and so it is impossible to enter the village boundaries on them. The only solution of the problem seems to be to compile new maps as far as possible from the reliable portions of the various surveys and then examine and correct them in the field before publication. The procedure would be then somewhat as follows:—The sheet having been projected, the village trijunctions would be plotted and the reduced settlement maps fitted on to the trijunction points and the detail entered. The streams, etc., would then be examined against the old Revenue Survey or Topographical maps to check or improve them. All new forest surveys would be reduced and entered as they stand and such hill work as appears reliable on the topographical maps would be entered. The sheets thus prepared would be taken into the field and examined and corrected and any blanks in them, and hills surveyed in. They would then be finally drawn and published.

It is manifest that in such patch work there is considerable danger of error and omission, and if all detail has to be examined thoroughly on the ground to ensure no omissions, it would probably be as quick and cheap and far more satisfactory to make a proper topographical survey *de novo*. The system, however, is being introduced now and will be given a thorough trial. If successful the detachment will require strengthening in order to cope with the work in reasonable time.

THE CENTRAL INDIA AND RÁJPUTÁNA AGENCIES.

Surveys.

Topographical surveys on the scale of 1 inch=1 mile of the Native States comprising these Agencies were commenced in the year 1860, and were carried steadily on until 1886, when the whole had been completed except a small portion of the desert part of Rajputáná, which remains to be surveyed by the party at present working in Sind.

As only Native States were concerned, no village boundaries were required and so only topographical parties were employed. The maps are consequently good sound topographical maps of excellently even quality, of standard sheet form and were all published within a year of the dates of survey.

The only exception to the scale was in the more desert portion of Rájputána, where the scale of survey and publication was reduced to that of $\frac{1}{2}$ inch=1 mile. A very small portion of that tract remains for survey but otherwise the whole area is mapped and if only some provisions be made for revising the sheets and preventing them from becoming obsolete, nothing further is at present required.

BOMBAY.

With the exception perhaps of the Native States of the Rájputána and Central India Agencies, the Bombay Presidency (excluding Sind) is better off for topographical maps than any other province.

Old surveys, Sind.

In Sind between 1856 and 1870 revenue surveys, similar to those of the Bengal Presidency were caried on on scales varying from 4 inches = 1 mile in the cultivated and riverain portions to 1 inch=1 mile in the hilly parts. The survey had the same characteristics as those described in Bengal. The boundaries were accurately surveyed, the interior topographical detail fairly so, while

the hill features were only approximately sketched. The usual 1-inch maps were made of these surveys.

Nothing further was done in Sind until 1892 when a survey of the river Indus on the scale of 1 inch=1 mile was undertaken. This was completed in 1895 and 1-inch maps of the river published. The topographical maps of this division being found so much out of date, a general topographical survey of Sind was commenced in 1895-96 and is now being prosecuted. The scale of survey is 2 inches=1 mile, and the maps are being published on the 1-inch scale, a few being available on the 2-inch scale also for local officials. When the survey is complete Sind will possess modern topographical maps throughout.

Bombay.

Turning to Bombay proper, the conditions here varied from those in Upper India. The Local Government has had its own Revenue Survey Department and the old system of village survey by revenue parties of the Survey of India was never carried on in this presidency and, with the exception of modern Forest surveys, the whole of the work executed by the Survey Department has been on topographical lines. The first portions to come under survey were Cutch, Káthiáwár and Gujarát, where topographical surveys were commenced between 1868 and 1870. These were completed about 1884. They were on the scale of 2 inches=1 mile, the resulting maps being published on the 1-inch scale; those of British territory being also published on the scale of survey. In British territory village boundaries were inserted, being taken from the maps of the local Revenue Survey. The survey and the maps were both excellent but are rapidly falling out of date.

In Khándesh and the Deccan survey parties were at work from 1871 up till as late as 1896, gradually extending the Topographical Survey until at length almost the whole province was mapped. The surveys have all been made on the same principle, a scale of 2 inches=1 mile was adopted for the field work, and the village boundaries either surveyed or entered on the maps from the local revenue surveys, the positions of the village trijunctions having first been fixed. The maps were published on the 1-inch scale.

The only remaining portion of the forest covered area in Kánara, is now under survey on the usual 4-inch scale adopted for forests, and from these larger scale maps, the 1-inch standard sheets are being prepared.

It will thus be seen that with the exception of the Sind division there are practically a complete series of topographical maps of the province. The older ones are, of course, a good deal out of date, but if only some system of periodical revision were in force, nothing more need be wished for.

MADRAS.

Local surveys.

The Madras Government has always had a Survey Department of its own, apart from the Survey of India. Its efforts have been mainly employed in preparing settlement and cadastral maps, though a certain amount of topographical work has been done by them. The result of the work has been put forward in the form of somewhat rough *taluk* maps, some on the 1-inch and some on the ½-inch scale. These appear to have been compiled by reducing the cadastral maps and incorporating the topographical work. From the appearance of the hills it is clear that no great attention was paid to the accuracy of their details, and in 1885 it was reported that the attempt to utilize the hill sketching of these maps in order to compile the Indian Atlas sheets on the ½-inch scale from them had failed.

Topographical Surveys.

Between 1867 and 1877 a Topographical Survey of the hilly and forest-clad portions of Ganjam and Vizagapatam was carried on chiefly on the scale of 1 inch = 1 mile, though some of the more inaccessible parts were surveyed on half that scale. Standard maps on the 1-inch scale of some 30 sheets of these districts were the result of this survey.

Forest Surveys.

In 1886 arrangement was made by which the Survey of India was to take over the completion of all the topographical work remaining incomplete in Madras. This was said to amount to about 13,500 square miles, situated in the following districts:—

Ganjam.	Madura.
Vizagapatam.	Trichinopoly.
Tinnevelly.	South Canara.

Malabar.

After working one year on this, the party was diverted from topographical work and employed solely on forest surveys on which it has worked to the present, so that practically no progress was made with the completion of the topographical blanks in the presidency. Thus with the exception of the before-mentioned sheets of Ganjam and Vizagapatam and the portions of sheets which can be compiled from the forest surveys, it is not possible to make any further progress with the standard sheets.

Efforts were at one time made to redraw the *taluk* maps in standard sheet form but it had to be given up, as the work was clearly not of a quality to warrant incorporating it in the final standard sheets of India.

MYSORE.

In the year 1874 a topographical survey of the Mysore State was commenced and carried through to completion, being finished in 1886. This consisted of a survey of the

whole country on the scale of 1 inch = 1 mile. Trijunctions of villages were fixed by topographers and the boundaries were inserted on the maps from the settlement maps which had previously been made by the Mysore Revenue Survey. These are an excellent series of maps and except that they must naturally be falling somewhat out of date leave nothing to be desired.

HYDERABAD AND BERAR.

The surveys of the Nizam's Dominions and the Hyderabad Assigned districts are among the oldest existing in India. The surveys appear to have commenced in 1816 and continued to 1847, Berar being surveyed between 1843 and 1850, a small portion being completed between 1856 and 1866. Little or nothing is known as to how these surveys were executed. They were mostly on the scale of 1 inch = 1 mile, though portions were done on the ½-inch scale. The maps were published by "*circars*," and from their appearance it is manifest that the survey was only a sketchy reconnaissance.

The sheets of this survey were redrawn and republished between 1884 and 1887 in standard form, the smaller scale work being enlarged to fill the blanks in the 1-inch surveys. Apart from the fact the work is 60 to 80 years old, the survey itself was never sufficiently good for modern requirements. It may be taken that for practical purposes, civil or military, no reliable maps exist of the Nizam's Dominions.

BURMA.

Up to the year 1879 the only maps of Burma in existence were those based on a reconnaissance survey on the scale of 1 inch = 4 miles, executed by Captain Fitzroy in 1860 and subsequent years. This was published on the same scale in four sheets.

Cadastral surveys.

In 1879 cadastral surveys were commenced in Lower Burma and, as is usual, 1-inch topographical standard maps were compiled from these of all the country cadastrally surveyed. These cadastral surveys have been more or less steadily prosecuted up to the present time and *pari passu*, the topographical sheets have been issued.

Cadastral surveys have now been carried on in the following districts.

Lower Burma.		*Upper Burma.*	
Hanthawaddy	1878-84	Kyauksè	1889-92
Bassein	1879-88	Mandalay	1890-91
Tharrawaddy	1880-83	Meiktila	1890-91
Pegu	1882-84 and 1895-97	Sagaing	1891-92
Shwegyin	1882-83 and 1897-98	Minbu	1891-95
Henzada	1882-85	Magwe	1892-95
Prome	1882-84	Shwebo	1892-98 and 1899-1900
Akyab	1883-87	Yamèthin	1892-98
Thóngwa	1887-91	Upper Chindwin	1893-98
Amherst	1890-96	Katha	1893-98
Tavoy	1891-96	Myingyan	1896-99
Toungoo	1896-1900	Lower Chindwin (in progress)	from 1899

Topographical Reconnaissances and Surveys.

After the annexation of Upper Burma in 1886, the usual demand arose for maps of the newly annexed country, and geographical reconnaissances were pushed rapidly over the country, the resulting maps being published on the ½-inch scale. As soon as the were found to be sufficiently complete for immediate requirements a commencement was made of a complete topographical survey, and in the year 1894 a rigorous topographical survey was commenced on the 1-inch scale in the Shan States by two parties. Subsequently in 1896 a third party commenced topographical survey in Upper Burma, it being employed partly on surveys over fresh ground and partly in revising and completing the maps which were compiled from the cadastral surveys. In hilly and broken ground the latter failed and their work has to be supplemented.

Within the last two years a party which had been employed on cadastral survey in Lower Burma has been converted into a topographical one, and is employed in revising and filling in gaps in the sheets already compiled in Lower Burma.

Forest surveys.

In addition to the above since the year 1882, surveys of the valuable forests in Burma have been steadily pushed on. These have always been surveyed on the scale of 4 inches = 1 mile, and form a valuable addition to our topographical knowledge.

Present state of mapping.

The outcome of those various surveys is that we have already a fair number of standard sheets available. Out of some 600 sheets in which the whole of Burma is comprised, 120 sheets have been published, some 34 of these lying in the Shan States and the remainder in Burma, principally in Lower Burma and in the neighbourhood of Mandalay. A good many of these latter sheets are only partially surveyed, and new editions will be required of them. Work is, however, going steadily on and in a reasonable time we may hope to have the more valuable portions of Burma properly mapped.

Narrative Report of CAPTAIN G. P. LENOX-CONYNGHAM, R.E., *Deputy Superintendent, 1st grade, on Latitude Operations.*

During the past season the party took up the work of determining latitudes at stations on the series of triangles which connect the N. E. Longitudinal with the Calcutta Longitudinal Series. The presence of the Himalayas along the former series is the cause of abnormal deflections of the plumb line in the northern part of the area traversed by the meridional chains of triangles on which work was begun. It was considered advisable therefore to reduce the intervals between stations of observation, so as to obtain complete evidence as to the law of variation of these deflections, and to throw light on certain peculiar features which have been noticed with regard to them.

The Zenith Sector is provided with means for turning the eye end through an angle of 90 degrees without interfering with the focussing screws. By doing this the micrometer screw is rendered parallel to the direction of motion of a star at culmination, so that the value of the micrometer can be conveniently determined by recording transits on the electric chronograph.

Before leaving Dehra I took a good set of such observations, and on my return from the field a second set; the intention had originally been to employ the mean of the two results, if reasonably accordant, in the reductions of all the observations made during the season, but the fact that I had been obliged to readjust my focus before beginning work at the second station rendered the first result applicable to the first station only. At each station I measured the difference of declination of several couples of well known stars, so as to be able to obtain a value of the micrometer screw quite independently. In addition to this the results of the observations for latitude at each station were separated into two classes, according as the difference of zenith distance measured by the micrometer is positive or negative and from the difference between the two means a correction to the provisionally adopted value of the screw was obtained.

The followiug table gives the results of the various determinations made:—

TABLE I.

Station.	Month.	By Transits.	By Couples.	By Latitudes.
		"	°	"
Dehra Dún	November . .	42·5610		
Sarkára	November . .		42·5373	42·5438
Sirsa	December . .		42·5405	42·5201
Bánsgopál	December . .		42·5304	42·5401
Bostán	January . .		42·5361	42·5549
Chandaos	January . .		42·5264	42·5477
Sankráo	Febuary . .		42·5442	42·5507
Salimpur	Febuary . .		42·5782	42·5553
Dehra	May . . .	42·5529		

The first determination at Dehra Dún and both those at Sarkára were made before the focus was readjusted, and I have employed the mean of the two last in computing the latitude at that station. I was disappointed to find so large a difference between the value by transits and that by the other methods. A very considerable amount of force is necessary in removing the eye end of the Zenith Sector before turning it through 90 degrees, and it is possible that in doing so some change may take place in the relative positions of the different parts.

When the eye end has to be removed and replaced there must always be some uncertainty as to whether the wires remain at exactly the same distance from the object glass, and consequently an uncertainty as to whether the value of the micrometer determined with the wires in the one position is applicable to observations made with them in the other. A design is required for a telescope which will turn as a whole in a collar attached to the horizontal axis. I do not think there would be any difficulty in constructing an instrument of this sort and I believe its advantages would be great.

The determinations made by couples of stars at the next five stations give very accordant results and the mean of the five has been adopted. I consider a value based on the observation of couples more trustworthy than one deduced from the latitudes, for the following reasons:—

1. The level correction in the case of couples, is usually very small.

2. The atmospheric conditions, and hence the refraction, are more likely to be the same for both stars when they lie close together in the heavens, than when one is to the north and the other to the south of the observer.

3. The errors of the N. P. D.'s of two stars lying close together, as given in any catalogue, are likely to be similar in sign and amount so that the difference between the two is likely to be very nearly correct.

The Zenith Sector was provided with a second Talcott level during the summer of 1899. The levels are No. 2 and No. 7, both made by Holmes, and both (I believe) filled with chloroform. They are good levels and their bubbles come to rest after disturbance in about 20 seconds, No. 2 generally a little more rapidly than No. 7.

In September 1899 a calibration diagram, on the system suggested by Lieutenant Tandy, had been made for level No. 2, and this diagram was used in computing the observations made on the Kaliánpur group. In November I made a series of observations with a view to constructing a diagram for level No. 7, which had just been mounted, and as to put a second level on the tester at the same time hardly adds to the labour, I put No. 2 beside it and thus obtained a number of observations with both levels.

I confidently expected that this new series of observations with No. 2 would corroborate the indications of the diagram, but when I came to compare them I found that this was not the case. A movement of the bubble as interpreted by the diagram had always too small an angular value. To examine the matter thoroughly I constructed a new diagram from the more recent observations and then copied it in pencil on the old, the result was to show an apparent shrinkage in the distance along the scale equivalent to a given angle. Thus the new 4″ line nearly coincides with the old 3″ one, the new 8″ with the old 7″ and the new 12″ with 9·5″ on the old diagram.

On my return from the field in May I had another set of observations made in order to see whether there was any further change. The mean value of 1 division of level No. 2 deduced from this set of observations was 1·0038″, whereas that deduced from the November series was 0·9694″, and that given by the diagram about 0·84″. It seemed, therefore, that a considerable change had taken place since the diagram was made, so that the latter could not be used again.

Throughout the field season I had taken care to keep the level corrections very low, so that in whatever way they were translated into seconds of arc there should not be much room for error, and under these circumstances I decided to abandon the calibration method until further light could be thrown upon it.

It is extremely difficult to see how a level which has been carefully treated can alter its curvature, and of course it is not certain that the changes found are really due to this cause. They may be due to irregularities in the screw of the bubble tester, though I confess I cannot regard this as probable, for to account for the change shown above, there would have to be 100 threads to the inch at one part of the screw and only 84 at another, or some equivalent irregularity.

It is more probable that the apparent want of stability is due to the tube not always having the same line of its surface in the vertical plane through its axis, so that the bubble is not always moving on exactly the same surface.

Great attention was always paid to this in placing the tube either in its cradle or on the Y's of the tester, and there cannot have been much variation in its position, for it is not difficult to judge of the bisection of the width of the bubble by the mark on the tube. It may be, however, that greater refinement is necessary; in which case some means will have to be provided for placing a cross-level on the tube itself. I do not think it would be sufficient to apply a cross-level to the cradle, for if a change in the level's value were found there would be no confidence that the tube had not moved slightly in its bearings and if for any reason the tube had to be removed from its cradle, a calibration diagram made previously would be of no further value.

If the changes found have their origin in the tube, and if tubes are as a rule liable to be so unstable in their behaviour, the calibration method will not be of practical value, for the labour of making a diagram cannot be undertaken unless its results are permanent. Moreover it is not as yet certain that the state of things recorded by a diagram is really that which exists in the tube; it may be a combination of the irregularities of the micrometer with those of the tube and other less obvious factors, and there is not sufficient evidence to enable one to say which is the most important of these elements.

In 1898-99 I had paid much less attention to keeping my level correction small than I did during last field season, and when the results proved to be of less precision than they should have been, I considered it probable that this was partly due to irregularities of the level tube, and that the calibration method which had just been elaborated by the inventor, Lieutenant E. A. Tandy, R.E., and which seemed most promising, would improve matters (for the observations had been computed using a mean value). It was under these circumstances that the diagram for No. 2 level was made.

Its use made a considerable difference, the probable errors of the final means being in every case reduced, and I considered that the evidence in favour of Lieutenant Tandy's method was strong.

I have lately, however, taken up these computations again, as they had been finished in great haste, and have scrutinised the level corrections more attentively. I have found that the change from mean value to diagram has not had the sort of effect that was to be expected, namely an irregular alteration as often of one sign as of the other, but has *reduced* the angular value, in almost every case. This has shown that the average value

given by the diagram was different from the *adopted* mean value, so that it was uncertain whether the reduction in the probable errors produced by the use of the diagram was due to the superiority of the calibration method or merely to the fact that the adopted mean value was incorrect. To elucidate this I have deduced an amended mean value from the diagram itself and have recomputed the results therewith. From the two sets of results thus obtained, *viz.*, those by diagram, and those by the amended mean value, I have calculated the probable error of observation in a latitude dependent on one observation of one pair of stars for each station. This probable error is free from all effect of errors of star's places. In the following table the results are given :—

TABLE II.

Station.	Probable Error of Observation.	
	Using diagram.	Using mean value.
	"	"
Daiádhari	±1·56	±1·52
Bhádrása	1·64	1·86
N. E. End of Base	1·12	1·10
Kaliánpur	0·75	0·75
Súrantál	1·05	1·05
Losalti	0·96	0·99
Tinsia	1·00	0·98
Kámkhera	0·96	1·01
Ahmadpur	1·28	1·26
Average	1·15	1·17

From this comparison it does not appear that the calibration possesses any advantage over the mean value, certainly no sufficient advantage to justify the large expenditure of labour which is involved in the construction of a diagram. It must be remarked, however, that owing, as I believe, to some looseness between the clamp of the level and the tangent screw, all the observations under discussion are liable to errors of larger magnitude than those which calibration is intended to do away with, so that the good effects of the latter may possibly have been masked.

As already stated, I abandoned the calibration method in computing last field season's work, and adopted, as the value of 1 division of the level scales, the mean of the November and May determinations.

The results were as follows :—

TABLE III.

Level.	November.	May.	Mean.
	"	"	"
No. 2	0·9694±0·006	1·0038±0·007	0·98660
" 7	1·1470±0·006	1·1745±0·007	1·16075

The increase in both values is remarkable. It is probably partly due to the fact that the mean lengths of the bubbles were greater in the May than in the November determinations; for it has frequently been noticed that the curve of a level tube tends to be flatter at the centre than towards the ends. I considered that it would be of interest to examine the discrepancies between the corrections indicated by the two levels. To this end I have tabulated the differences beween the correction by a single level and the mean of the two, and treated them as if they were differences between individual measures of some quantity and the mean of a large number. That is to say, I have treated the mean of the two levels as if it were the true value and so found how much a single level is likely to be in error.

The following table shows the probable error of a *single* level correction at each station, and also the number of residuals from which it was formed.

TABLE IV.

Station.	N.	$\cdot 6745\sqrt{\frac{(vv)}{n\cdot 1-1}}$
		"
Sarkára	87	±0·198
Sirsa	92	±0·205
Bánsgopál	115	±0·176
Bostán	106	±0·128
Chandaos	96	±0·133
Sankráo	135	±0·222
Salimpur	94	±0·220

These results are fairly accordant and show that the behaviour of the levels was tolerably uniform.

This investigation does not give any indication as to the relative merits of the two levels. In order to distinguish between them, abstracts of the colatitude by each level independently have been made and the probable error of the mean by each has been computed. The following table shows the results obtained :—

TABLE V.

Station.	Colatitude and Probable Errors Level No. 2.	Colatitude and Probable Errors, Level No. 7.
	"	"
Sarkára	24·86±0·065	24·96±0·063
Sirsa	29·75±0·067	29·70±0·072
Bánsgopál	36·73±0·053	36·69±0·050
Bostán	5·73±0·049	5·73±0·038
Chandaos	59·37±0·042	59·29±0·033
Sankráo	30·96±0·048	30·97±0·046

From the above it seems that No. 7 level is slightly superior to No. 2, and also that either would have given more accordant results than were obtained at Kaliánpur with level No. 2 during the preceding season. I believe this to be principally due to the improvement in the clamp which attaches the level to the setting circle.

It is satisfactory to notice the good agreement between the mean results by each level; the difference between them in only two cases exceeds the probable error.

This accordance seems to show that the principal source of the discrepancies between individual observations is not the level correction; for, unless the levels were of widely different quality, the mean correction from the two must be more accurate than that from one alone, so that we are forced to conclude that the dislevelment as given by a single level is so nearly true that even if it were freed from all error the total error of an observed latitude would not be materially reduced. Experiment has shown that the probable error of an intersection is greatly less than that of a latitude, so that it appears that the discrepancies found are mainly due either to the star's places or to uncontrollable causes such as variable refraction.

The average probable error of a colatitude deduced from two observations of one pair of stars is ± 0·301"; and by examining the observations at Sankráo, where a number of pairs were observed 4 or even 5 times, we find the probable error of observation in one observation of a pair of stars is ± 0·310", so that the probable error of the mean of two observations would be $\frac{0·310}{\sqrt{2}}$ = ± 0·219"; hence if we call the probable error of the mean of the N. P. D's of two stars ϵ we have—

$$\epsilon^2 + (·219)^2 = (·301)^2$$
$$\epsilon^2 = 0·042640$$
$$\epsilon = \pm 0·206$$

and therefore the probable error of a single N. P. D. is ± ·206 $\sqrt{2}$ = ± 0·291".

Taking the Sankráo observations alone and treating them *more rigorously*, we find the probable error of the quantity $\frac{1}{2}(\Delta_1 + \Delta_2)$ to be 0·274", and hence the probable error of a single N. P. D. to be ± 0·387". It is difficult to say which is the more trustworthy of these two values. The mean may be accepted.

We have therefore with the Zenith Sector the probable error of observation in a single colatitude ± 0·310", whereas in 1890-91, with the Zenith Telescope the probable error of observation was ± 0·477" (*vide* Annual Report of 1890-91, Appendix, page 10).

Also we have now, using as far as possible Newcomb's Catalogue of Fundamental stars, the probable error of a single declination ± 0·340" as against ± 0·710" in 1890-91.

A careful scrutiny of the results has been made to see whether there is any evidence of a systematic difference between the colatitudes according as the direction of motion of the instrument between the observations of the two stars of a pair was from east to west, or west to east.

The results are as follows :—

TABLE VI.

Station.	(E-W)−(W-E).
	"
Sarkára	−0·440
Sirsa	+0·154
Bánsgopál	+0·090
Bostán	+0·331
Chandaos	−0·042
Sankráo	−0·082
Salimpur	−0·047
Sum	−0·036
Mean	−0·005

There is no evidence here of any systematic difference. The following tables show the final results of the season's work:—

TABLE VII.

Budhon series.

Station.	Observed Latitude.	Computed Latitude.	O—C.
	° ′ ″	° ′ ″	″
Sarkára	29 15 35·12±0·060	29 15 46·92	—11·80
Sirsa	28 54 30·30±0·044	28 54 39·64	—9·34
Bánsgopál	28 33 23·31±0·050	28 33 28·07	—4·76
Sankráo	28 2 28·95±0·049	28 2 28·99	—0·04
Salimpur	27 46 36·26±0·048	27 46 36·46	0—·20

Great Arc.

	° ′ ″	° ′ ″	″
Nojli	29 53 14·12 (observed in 1864)	29 53 27·76	—13·64
Kaliána	29 30 47·98 (observed in 1840)	29 30 54·70	—6·72
Datairí	28 43 58·67 (observed in 1864)	28 44 4·49	—5·82
Bostán	28 30 54·28±0·060	28 30 59·64	—5·36
Chandaos	28 5 0·74±0·049	28 5 1·59	—0·85
Noh	27 50 53·13 (observed in 1864)	27 50 53·08	+0·05

The sudden drop in the apparent local attraction between the stations of Nojli and Kaliána (a distance of only about 26 miles), its steadiness as far as Bostán, and then the rapid decrease in the interval between that station and Chandaos are remarkable.

The next step that seems to be indicated in investigating this matter is the detailed examination of the interval which separates Nojli from Kaliána. To do this a secondary triangulation of fair accuracy will have to be executed so as to fix say five intermediate points, which would thus be about 4 miles apart. The task is simplified by the existence of the intermediate principal station of Dahera, and if a few of the old secondary points can be identified the matter will be extremely easy.

Probably two nights of observation would suffice to give a sufficiently accurate value of the latitude. Further information is also required as to the rate of increase of Himalayan attraction between Nojli and the next latitude stations to the north, namely, the east end of the Dehra Dún Base and Amsot. Unfortunately the presence of the Siwálik Range allowed the use of long rays, and there are no principal stations between these places, so that, unless secondary points can be identified with certainty, some triangulation will be necessary. It is particularly desirable that a station should be found to the south of the Siwáliks and symmetrical to the east end of the Base with regard to them, so that an idea may be formed of the effect on the plumb line of a mass of their magnitude.

In the annual report of last year the results of the observations round Kálianpur were not final, as the computations had not undergone any scrutiny after completion. I therefore append to this report two tables showing the final values. The results have been carefully discussed by Major Burrard in a note written for the International Geodetic Conference, which met at Paris in September 1900.

Azimuth Observations.

Station.	Azimuth.	°	′	″	Observed—Computed.
					″
Daiádhari	Observed	303	32	52·52	
	Computed			50·41	+2·11
Bháorása	Observed	95	12	39·36	
	Computed			38·08	+1·28
N. E. end of Base	Observed	80	46	34·13	
	Computed			31·61	+2·52
Kaliánpur	Observed	190	27	6·24	
	Adopted			5·1	+1·14
Losalli	Observed	305	52	55·80	
	Computed			57·30	−1·50
Tinsia	Observed			.....	
	Computed			.....	.....
Kámkhera	Observed	154	45	36·67	
	Computed			35·31	+1·36
Súrantál	Observed	10	27	43·33	
	Computed			40·46	+2·87
Ahmadpur	Observed	185	10	56·27	
	Computed			53·91	+2·36

Latitude Observations.

Station.	Latitude.	°	′	″	P. E.	Observed—Computed.
					″	″
Daiádhari	Observed	24	38	18·80	±0·135	+1·23
	Computed			17·57		
Bháorása	Observed	24	8	5·22	±0·134	+1·49
	Computed			3·73		
N. E. end of Base	Observed	24	8	55·49	±0·082	+1·92
	Computed			53·57		
Kaliánpur	Observed	24	7	10·50	±0·077	−0·76
	Computed			11·26		
Súrantál	Observed	24	14	21·40	±0·082	+0·98
	Computed			20·42		
Losalli	Observed	24	6	18·32	±0·091	−0·85
	Computed			19·17		
Tinsia	Observed	24	6	29·09	±0·089	+1·12
	Computed			27·97		
Kámkhera	Observed	23	59	42·97	±0·069	−1·96
	Computed			44·93		
Ahmadpur	Observed	23	36	18·51	±0·072	−2·37
	Computed			20·88		

The results of the azimuth observations are the same as those supplied to Major Burrard; they differ slightly from those given in last year's report on account of the adoption of the declinations given in Professor Newcomb's Catalogue of Fundamental Stars.

The Latitude observations have been revised since Major Burrard's report was written, but the changes introduced are very small, the largest being 0·16″. The revision was made with a view to examining the relative merits of a mean value and of a calibration diagram for computing the level corrections. No marked advantage of the one over the other being shown up, it has been considered best to adhere to the recognised plan of using a mean value, which at any rate has the advantage that its results can be easily understood and checked by any one who may require to recompute the observations, whereas unless a copy of the diagram were attached to the records the level corrections derived from it could never be re-examined.

The changes in the mean latitudes are as follows:—

Station.	Latitude by Diagram, —Latitude by Mean Value.	Probable Error	
		By Diagram.	By Mean Value.
	″	″	″
Daiádhari	+0·05	±0·105	±0·135
Bháorása	−0·09	0·132	0·134
N. E end of Base	−0·03	0·084	0·082
Kaliánpur	−0·04	0·083	0·077
Súrantál	+0·01	0·073	0·082
Losalli	−0·01	0·093	0·091
Tinsia	+0·02	0·090	0·089
Kámkhera	−0·02	0·068	0·069
Ahmadpur	+0·08	0·073	0·072
Average	−0·003	±0·089	±0·092

Narrative report by MAJOR T. F. B. RENNY-TAILYOUR, R E., *Superintendent, 2nd grade, on the Survey Operations with the Burma-China Boundary Commission, season 1899-1900.*

The Survey Party detailed to accompany the Boundary Commission is given in the margin. This was the third and last season of the Commission and, as the portion of the boundary left for delimitation was only about 200 miles in length, it was not considered necessary to work in two detachments, as in former seasons. Mr. J. G. Scott C.I.E., was the British Commissioner, General Liu and Mr. Ch'ên represented China as joint Commissioners. The programme arranged was to start work from the last cairn put up by the Northern Party on the Nam Ting during the season 1898-99 and to demarcate southwards to the first cairn put up by the Southern Party on the Nam Hka during the same season. Owing to the hostile attitude of the Was, who were on our side of the boundary, it was decided that both the British and Chinese Commissions should march through Chinese territory. As the country was practically unmapped, the survey party was necessarily a large one. The Chinese were supposed to be entirely responsible for the safety of all connected with the British Commission while in China, and, besides the signallers and 25 Burma Sappers and Miners, it was proposed only to take a small escort, mainly for ceremonial purposes and consisting of 50 men of the Durham Light Infantry under Major Morley Saunders. There was also a reserve escort consisting of 200 Gurkhas and 50 Kachins of the Military Police under Captain Ffrench-Mullen. As it turned out, however, it was always found necessary to have some of the reserve escort with the Commission.

Major T. F. B. Renny-Tailyour, R.E.
Munshi Ikbaluddin.
Surveyor Mahmud Husain.
" Abdul Rahim.
Sub-Surveyor Mowni Ram.
" " Hazrat Ali.
Interpreters and *Khalasis*.

The Commission was delayed a few days owing to the difficulty of obtaining sufficient carts, but eventually started from Mandalay on the 19th November 1899. There had been very late and heavy rains and the roads were in a bad state. Lashio, where the cart road ends, was reached on the 5th December and a halt of two days was made to take over mules and to arrange the baggage into suitable loads. The Commission finally arrived at Ho-pang, a village in British territory near the Nam Ting, on the 18th December. It had been arranged that we should meet the Chinese Commission here and they marched in on the 22nd. We were also joined at Ho-pang by Mr. Litton, the Consul at Ssu-mao, who had been appointed Chinese Adviser to the Commission.

As Mr. Scott was particularly anxious that I should be present if possible at all the conferences my plans for the survey party had to be arranged with this end in view, and I was, of course, unable to get away from the Commission for any length of time. As a matter of fact I frequently got away for a few days; and when the Commission was on the march between important places I nearly always managed to visit several stations and to rejoin again within a day or so of its arrival.

There being no triangulation along the line we were going, I decided to send on Ikbaluddin to prepare stations, taking a safe line through China but as near the boundary as possible. As it was certain that the haze would be very dense later on, Ikbaluddin was instructed to take as many observations as possible, and when he came to the end was to connect on to Captain Hare's boundary commission triangulation of 1898-99 and to return to meet me, finishing the observations at the stations he had prepared on his way back. It was most important that we should have some idea of the country in front of us, consequently, I also sent Hazrat Ali who, with Ikbaluddin's assistance, surveyed the country roughly on the ½-inch scale, traces being sent back to me every week or ten days. With the stations prepared for me I hoped to run a very good series and, by working the triangulation out roughly as we moved on, to keep the plane-tablers always supplied with fixed points.

Mahmud Husain was principally employed on special little expeditions into China, Abdul Rahim and Mowni Ram being kept almost entirely for the boundary work. I intended to have the actual boundary surveyed on the 1-inch scale as in former seasons, but beyond No. 3 cairn it was impossible to move near the line and consequently useless continuing a larger scale than the ½-inch. The Chinese made little or no objection to my plans for Ikbaluddin and Hazrat Ali, and agreed to send an escort with them consisting of an officer and 10 Chinese soldiers. It was also decided that, in conjunction with the Chinese, a small party with surveyors should be sent to make local enquiries about the first part of the boundary, Mr. Sutherland, the local civil officer, representing us.

At my request Captain Turner, Suffolk Regiment, who was the Intelligence Officer with the Commission, arranged to take Mahmud Husain and to make a fortnight's tour to the north-east, visiting Mêng Hom, the correct position of which place I was particularly anxious to obtain.

I took advantage of Mr. Sutherland's party being sent out and started myself on the 29th December to commence the triangulation, visiting three stations of the 1-inch series brought up by No. 21 Party. I returned to Ho-pang on the 4th January, found the Commission had moved on to Man Hka and rejoined them there on the 6th. The Commission had moved on owing to Mr. Sutherland's party having come to a standstill at Man Hka, the Chinese refusing to do anything or go anywhere until the Commissioners came on.

While at Man Hka we settled a few miles of the boundary line and together erected three cairns.

Owing to the disturbed nature of the country it was considered impossible to go along the boundary beyond No. 3 cairn until, at any rate, the neighbourhood of Mêng Kaw and Mêng Tum, and the Commissioners therefore decided to move on to Mêng Kaw, making a considerable detour through China.

The Commission left Man Hka on the 14th January and halting a day or two at Mêng Ting and Kêngma *en route* arrived at Mêng Kaw on the 29th. I arrived a couple of days later. I met Ikbaluddin at Kêngma; he had experienced difficulties with some of the local Chinese officials, who had refused to let him proceed further than Mêng Hsüng. The matter was represented to General Liu, who at once made arrangements that there should be no further obstruction.

At our conferences with the Chinese at Mêng Kaw we found there was little chance of our coming to any satisfactory settlement even as far as this neighbourhood, and Mr. Scott found it necessary to refer to our Government for orders. While waiting for an answer Major Kiddle, R. A. M. C., our Medical Officer, and Mr. Sutherland were murdered and Mr. Litton wounded by Was near Mêng Tum, a large Chinese Shan village about 8 miles off Mêng Kaw, where they had gone to see the Bazaar. This unfortunate occurrence put a stop, for a time, to the boundary negotiations. It became necessary to punish the Was, and at the request of General Liu the reserve escort was ordered up, arriving at Mêng Kaw on the 24th February. In the meantime the Chinese had collected a force of upwards of 2,000 men. We marched to Mêng Tum on the 26th, turned the Was out of several stockades that afternoon, and on the 27th had a combined movement with the Chinese, punishing the Was severely. They probably lost altogether 50 to 60 killed, 150 to 200 wounded and had a number of fine villages burnt to the ground. The British force had 1 killed and 9 wounded, and the Chinese about 8 killed and 40 wounded. It was on the whole a very satisfactory business.

The Was certainly did not appear such good fighting men as we anticipated, being in my opinion inferior to the Kachins. The Chinese soldiers on the other hand surprised us by their dash, but, although armed with magazine rifles, their shooting was wretched.

We halted the 28th at Mêng Tum and on the 1st March the Commission started off for Mêng Nim Taü, arriving there on the 10th. While at Mêng Nim Taü we had several conferences with the Chinese but got no nearer a settlement than before, and it now became certain that it would be impossible to come to terms with them. The Commission consequently started off again on the 23rd and halting 3 days at Mainai and 9 days at Pangnaw (part of which time was spent in fruitless arguments with the Chinese) arrived at Mêng Ma on the 16th April.

By the time we had arrived at Mêng Nim Taü, the haze had become very dense, and I was extremely anxious about my triangulation; rain, however, very luckily came on just as we were leaving that place and I was able to carry on the work. I met Ikbaluddin at Pangnaw. He had connected on to Captain Hare's series and, having observed at his stations on his return march the triangulation was practically complete between Mêng Tum and Mêng Ma. I was able to send Mahmud Husain with Captain Turner on several small tours, getting a good deal of new country surveyed.

We had a final conference with the Chinese at Mêng Ma, when Mr. Scott announced that he intended to put up a cairn where we considered the boundary came down to the Nam Hka and he asked the Chinese to send delegates, but they refused.

We formally separated from the Chinese at Mêng Ma on the 20th, after exchanging very cordial farewell calls, and arrived at Panghsang in British territory on the 21st April. Mr. Scott went on at once to erect the cairn on the Nam Hka, returning to Panghsang on the 27th April. While at Panghsang I had a special map drawn for Mr. Scott to send to the Chinese, showing what we considered was the boundary, and a despatch was also sent informing them that they must respect this line.

The Commission left Panghsang on the 2nd May and after a very wet march reached Nawnghkio on the 26th. The Mandalay Kunlong railway had just been opened up to Nawnghkio; we therefore left by rail on the 27th, arrived at Maymyo that evening and at Mandalay on the afternoon of the 28th May. Mr. Scott, as usual, took a great interest in the survey work and gave me every assistance. I am also indebted to Captain Turner, who made several tours from the Commission and invariably gave Mahmud Husain every facility to survey new country. During the march back a rough map to be attached to Mr. Scott's report was drawn.

A triangulation series was carried on continuously; 35 stations were observed from and more than 200 new points were fixed in an area of over 5000 square miles. The triangulation which had been partially worked out in the field was carefully computed at Bangalore, commencing from both ends, and the connection which was made near Pangnaw was extraordinarily close, the mean giving an error of less than a second in both latitude and longitude.

Except for a short time at Mêng Kaw the surveyors were continuously employed, and altogether an area of about 7,500 square miles of new country was surveyed on the ½-inch scale and 75 square miles on the 1-inch scale, practically the whole of the work being based on triangulation. At Bangalore the 1-inch survey was incorporated in the last of the 1-inch boundary sheets of the season 1898-99 and the ½-inch survey is being incorporated in the ordinary ½-inch sheets of Burma and Yünnan.

The country passed through was hilly, fairly open and very healthy in the cold weather. The temperature was generally cool and pleasant.

Ikbaluddin proved himself a very energetic and hard working officer and displayed great tact in the way he managed to get along with the Chinese. Mahmud Husain is a very accurate and hard working surveyor, and I am very sorry he is taking his pension and leaving the department. Abdul Rahim is an experienced surveyor and a very quick worker, as usual he got on very well with the Chinese, thereby greatly facilitating the work. Mowni Ram is a good plane-tabler and worked very well. Hazrat Ali is very keen and promises to turn out a very capable surveyor. His knowledge of Chinese was most useful.

Narrative report of CAPTAIN C. L. ROBERTSON, R.E., *Officiating Deputy Superintendent, 1st grade, on Survey Operations with the Mishmi Expedition, season 1899-1900.*

Sanction having been accorded by the Government of India to the despatch of a military punitive expedition during the cold weather of 1899-1900 against the Mishmi tribe inhabiting the country beyond the north-eastern border of Assam, and the appointment of a survey detachment to accompany this expedition having been approved by the Foreign Department, I received instructions from Colonel Hobday, Deputy Surveyor-General, Revenue Branch, while in Shillong in October 1899, to form the necessary detachment from the members of No. 14 Party and, after having despatched the party to the field from Silchar, to myself proceed from that place in charge of the detachment and join the force operating against the Mishmi tribe at Sadiya, in north-east Assam.

In compliance therefore with these instructions I formed the small survey detachment detailed in the margin and, on the 13th November 1899, having previously arranged for the supply of the necessary equipment from the Mathematical Instrument Office, Calcutta, and having duly started No. 14 Party into the field from Silchar and handed over charge temporarily to Mr. Waller-Senior, left Silchar and proceeded by rail and steamer *viâ* Goalundo and Dibrugarh to Sadiya. Sub-Surveyor Dharmu had been left at Shillong, practising survey on a small scale when the party was transferred from recess quarters to Silchar and, with four of the menials of the detachment, he now joined me at Gauhâti and proceeded with me to Sadiya. We reached Dibrugarh on the evening of 22nd November and halted there one day to arrange about funds for the detachment, as well as the means of transport on to Sadiya, and to store such baggage as it was not absolutely necessary to take on into the field. On the morning of the 24th idem I left Dibrugarh and, travelling by rail as far as Tâlap and thence by road, reached Sadiya and reported myself there to Lieutenant-Colonel Molesworth, commanding the expedition, on the 25th November 1899.

Captain C. L. Robertson, R.E., Officiating Deputy Superintendent, 1st grade, in charge.
Sub-Surveyor, Dharmu.
16 menials.

The country which was to be visited, *viz.*, that inhabited by the Mithun (Bebejiya) Mishmis, was practically unexplored, though parts of that inhabited by the other division of the tribe, the Midu (Chulikata) Mishmis, had been visited before notably by Captain Woodthorpe in 1877-78, when he succeeded in surveying the greater part of it as well as a portion of that of the Mithun Mishmis on the scale of 4 miles = 1 inch. A considerable number of the high peaks in the country had, however, been fixed trigonometrically from the stations of the Assam Valley Principal series, enough in fact to more or less define the position of the high range of mountains lying to the north of the Mithun Mishmi country. These, as attaining altitudes of from 13,000 to 15,000 feet above sea level were known to be inaccessible, at any rate in winter, and it was therefore known that the area over which it would be possible to carry out survey operations in conjunction with the military operations of the expedition would perforce be very limited. The proposal put forward by Mr. Needham, the Political Officer with the expedition, for undertaking the exploration and survey of the unknown portion of the Abor country as far as Gyála-Sindong on the Sángpo river, had not been approved by the Government of India.

I decided to adopt the scale of 2 miles = 1 inch for such topographical surveys as I might be able to carry out, as allowing of delineation in greater detail than would have been possible on the 1-inch scale (that hitherto adopted in surveys of this part of the trans-frontier country), and as being a scale more nearly resembling that to which the native surveyor had been accustomed in the Lushai Hills. It was hoped moreover that it would be possible to resurvey on this larger scale much, if not all, of the country previously surveyed by Captain Woodthorpe on the smaller one.

As such triangulated points as were fixed in the country were peaks of the high mountain ranges fixed only by intersection from the stations of the Assam Valley series from great distances, and as there were practically no points fixed on the lower hills and in the valleys of the country on which it would be possible to base the detail topographical survey, it was considered important that in addition to the execution of such detail survey some sort of a series of triangulation should be carried forward into the country with a view to assisting the plane-tablers and also, if possible, obtaining more information of a definite geographical interest regarding the peaks and mountain ranges away to the north in a country over which no triangulation of any sort had hitherto been extended. This,

however, was no easy matter, owing, in the first place, to the difficulty of obtaining a base from which to extend and, in the second place, to the length of the initial rays. The Assam Valley 1st Class Secondary series had been carried along the banks of the Brahmaputra river, the stations being erected in the forest and presumably rays cleared at the time through the forest between stations. In the 20 or 25 years, however, which had elapsed since the execution of this series many of the stations had been entirely carried away by the different large rivers, and the forest had everywhere grown up to an extent which not only made it very difficult to find such stations as were still extant, but which, where they were found, rendered it impossible to see anything from them without an expenditure of time and labour in jungle-clearing which, in the present instance, it was not possible to undertake. Between the river, moreover, and the outer range of hills to the northward, across which the expedition was to advance into the country, lay an absolutely flat tract from 30 to 40 miles wide, covered with a dense tropical forest and utterly uninhabited. In this it was, of course, out of the question to think of making any stations, and it was therefore necessary that the first ones of any triangulation which was to be carried forward into the country should be from 40 to 50 miles distant from the stations of origin—a long distance, but one over which, given fine weather, it was quite possible that observations could be conducted.

On arrival at Sadiya I proceeded to complete the equipment of the detachment and then to arrange for the selection of the base from which to extend the triangulation operations. Here, however, I experienced considerable difficulty, as the information of the local civil authorities, on whom I had to depend for assistance, proved to be very far from accurate, and a good many days were wasted in attempting to find stations which no longer existed or which, when found, were useless for the purpose of extension. One station, that on the roof of the Sadiya Quarter Guard, was found in good preservation, and so situated as to afford an excellent view of the Mishmi hills, and on the 7th December 1899, thinking it inadvisable to remain longer behind the force which had moved forward from Sadiya more than a week previously, and having been assured both by the civil authorities and by the villagers of the locality that the station at Paropora, lying in a west south-west direction down the Brahmaputra river, was in existence and that a good view of the Mishmi hills was obtainable from it, I marched with the detachment from Sadiya, leaving 2 heliotropers with a 9-inch instrument at that place and sending 2 more men with a similar instrument down the river under arrangements made by the civil authorities to remain at Paropora and, after having had such jungle-clearing as might be necessary carried out, to signal to me from that station when required. The base Paropora H. S.—Sadiya Quarter Guard H. S. was computed, and it was proposed to observe astronomical azimuths at each of these stations on return of the expedition. They were not mutually intervisible. During the halt at Sadiya Sub-Surveyor Dharmu had started plane-tabling, taking rays from the H. S. to the different features in the hills whenever the weather, which had been more or less unsettled, allowed of his seeing them.

Bomjur was reached on the 8th December and a halt of a day was made here to allow of the survey of the Dibang river at this point and of parts of the hills which were visible from its banks. On the 10th the head-quarters of the force were overtaken at Grimbum camp at the foot of the hills and here a halt was made pending permission to advance and join the road party on ahead. The topographical survey of the lower hills was meanwhile carried on though the jungle was very dense and the difficulties of seeing enough fixed points to obtain plane-tablefixings very great. On the 9th instant a reconnoitring party had been to the top of the pass over which it was proposed to advance, but, beyond finding it very much higher than had been anticipated, had been able to see nothing owing to fog and snow.

On the 13th a move forward was again made and on the next day the advanced road party was overtaken. As there were no troops ahead of this and special escorts for the survey detachment could not then be spared, I received orders that I was not to proceed in advance of the road party. On the 15th, however, a reconnaissance was again sent on to the pass, and this the survey detachment accompanied, and reached the top of the hill above the pass, at an elevation of about 9,500 feet above sea-level, late on that afternoon. From here, by climbing a tree, a view of the valley of the Ithun river was obtained, but survey, without clearing a great amount of forest, was not possible and for this there was not time. The next day the reconnaissance was continued along the ridge to the eastward of the pass and from here a little survey was possible where the forest was open enough to allow of a plane-table fixing being made. The reconnaissance again returned to their former camps down the southern face of the hill that evening. The ascent to the pass proved a very difficult one and the whole range from top to bottom was found to be covered with heavy forest and dense undergrowth.

On the 18th an advance was again made to the camp 3 miles below the pass, and on the 19th survey of the country on the north side of the range, the valley of Ithun river and the Mithun Mishmi country was regularly commenced from the top. Movement, however, was very restricted, partly owing to the difficulty of cutting paths through the forest and clearing spaces wherever it was desired to make fixings and partly to the fact that, pending the arrival of the main body of the expedition, regular escorts for the survey parties could not be furnished. Work, however, was pushed on every day as much as circumstances would permit, small escorts being obtained from the road parties in exchange for coolies.

On the 19th two very high snow mountains lying about north-west by north of the pass, probably at a distance of some 150 to 200 miles, were first seen and it was decided, if possible, to fix these trigonometrically.

On the 20th the main body of the force arrived and thereafter there was less difficulty about providing escorts for the survey parties. Steps were now taken to regularly start triangulation. The two points which I proposed making my first stations of observation were Sajuba Peak on the east of the Máhu Hakra Pass, an intersected point of the Assam Valley series, 11,600 feet high, and a lower point some 6 miles to the west of the pass. On military grounds Colonel Molesworth was unwilling that the former of these should be visited till after part of the troops had crossed the pass and obtained a footing in the country beyond. I, therefore, directed my attention to attempting to visit the point I had selected on the west of the pass and erecting a station there. On the 21st and 22nd attempts were made to reach this point, but owing to the impossibility of moving at a quicker rate than 2 miles in 3½ hours through the forest and snow, with which the top of the range was covered, the attempt had to be abandoned, and another point nearer camp was selected instead, and a station erected on it on the afternoon of the latter day. The weather, however, which, since the storm of the 8th and 9th had been perfect, now began to show signs of breaking up. As every available man in the force was now required to bring up rations with a view to an early move across the pass into the Mishmi country, and as there were reports of the enemy being in the neighbourhood of the camp, escorts were again a difficulty for the next 2 days. On the 25th, however, the station on the west of the pass was again visited for the purpose of completing observations there. It was found, however, on reaching the top of the hill in the morning that the plains were covered with a dense white mist, through which it was impossible to get signals from either of the two base stations, and before this mist cleared off the clouds formed on the hill rendering all further work that day impossible.

From the 25th December 1899 to the 1st January 1900 these atmospheric conditions prevailed and no triangulation could be done, though on the 27th by waiting for gaps in the clouds I was able to obtain a few observations, though of a not very satisfactory nature. During this time I visited the station almost daily in the hope of even a temporary change for the better in the weather. The Sajuba Peak as being much higher, more difficult of access, and more deeply covered with snow, I considered it unwise to attempt to reach till the weather became definitely fine again.

On the 28th December Colonel Molesworth and the greater part of the force crossed the pass. I decided to remain behind till such time as the rations for the force should be put across and the remainder of the troops withdrawn in order that I might, if possible, start the triangulation before crossing, should the weather by turning fine make this possible. On the 2nd January, however, snow commenced to fall and continued to do so for the next 4 days, putting any further chance of reaching either of the selected points on the range out of the question, even should the weather turn fine, and also, owing to the large trees which, after the 2nd day's snow, were continually falling with its weight, making existence in the forest a matter of very considerable danger to everyone. On the afternoon of the 6th January the snow ceased falling but, as the barometer indicated very much worse weather than had hitherto been experienced, and fearing that any further delay might entail my being prevented by the snow from following the force into the Mishmi country at all, I decided to make the attempt of crossing the pass with my detachment next morning. This attempt I carried out next day in face of a very heavy snowstorm, losing one coolie frozen to death and some 15 out of a total of 30 more or less badly frost-bitten. Some of these subsequently lost portions of their feet; and it was only by myself cutting steps for them in the snow at the steeper parts of the descent that I managed to induce them to perform the journey down from the pass at all.

On the 11th I joined Colonel Molesworth and the head-quarters of the force at Hunli village, the first of the Mithun Mishmi villages met with on this line of advance. I had *en route* heard of Colonel Molesworth's intention to proceed through the country with only a portion of his whole force, sending the remainder back across the pass with orders for part of them to proceed round *viâ* Nizám Ghát and thence up towards Kaladoi village, and improve the road. On learning this I decided to send back Sub-Surveyor Dharmu and his squad to get as much of the outer hills as possible surveyed and also those along the Nizám Ghát line of advance, arranging as far as he was able by letter that whoever went in command of the party this way should furnish escorts for the surveyor accompanying him. I myself undertook the survey of the interior of the country. As the weather still appeared utterly unsettled, and further triangulation therefore not possible, I decided to send back the theodolite and extra *khalásis* with Sub-Surveyor Dharmu to wait at the advanced base at Bomjur. Now again there were difficulties about the provision of escorts, as, owing to the snow having prevented stores crossing the pass as originally intended, there was considerable anxiety on this score and all but a few troops had been sent back to bring the food over before it should run short on ahead. Survey operations were therefore for the time confined to the neighbourhood of the camp. On the 17th however all the commissariat had reached camp and the next day a reconnaissance was sent out for 4 days up the valley for the purpose of destroying certain of the Mithun Mishmi villages. This reconnaissance I obtained leave to accompany and in the course of the next 4 days managed to complete the survey of the upper end of

the Ithun valley and its tributary streams. It was impossible, however, to do more than sketch much of this part of the country owing partly to the inability of getting far enough eastward and partly to the unsettled state of the weather, as, when not actually raining, the clouds were hanging on all the higher hills as well as in many places in the valleys. On the 21st the reconnaissance returned to head-quarters at Hunli village and the next day such of the force as was now to proceed through the country started down the valley.

Survey was continued from along the line of march though, owing to the extremely difficult nature of the country and consequently very slow rate at which it was possible to move, as well as to the denseness and ubiquity of the forest, it was not possible to do work off the line of march except on such days as the force halted. The weather, too, which from the date of leaving Hunli village had been comparatively fine, that is to say, it had not rained and the valleys had generally remained clear of cloud and mist though the higher hills were seldom visible for more than a few minutes at a time, set in thoroughly bad on the 26th and remained so for the rest of the time that the force was in the country. This made the part of the programme of survey operations which included the resurvey of the part of the country previously surveyed by Captain Woodthorpe on the smaller scale impossible, and also prevented the survey of a considerable portion of the valley of the Tong (Dibang) river to the north of Captain Woodthorpe's work which, had the weather been less unfavourable, it had been possible to accomplish. The route taken down the valley kept to the left bank of the Ithun river and the border between the Mithun and Midu sections of the tribe was crossed on 28th, and Kaladoi, the furthest point reached by Captain Woodthorpe in 1879 was entered on 29th. Here a halt of 4 days was made, the country for nearly the whole of this time remaining enveloped in a thick mist and a downpour of rain.

On the 1st February a party of 50 rifles was despatched on the lightest possible scale of transport to Aiumimi's village (Anaia on the map), some 3,000 feet up on the right bank of the Ithun river, for the purpose of destroying it, and this party I accompanied. The path was an exceedingly difficult one and was acknowledged as such even by the Mishmis themselves, and the weather again rendered survey of anything but the immediate neighbourhood impossible, though had it been fine much very useful work might have been done from here. On the 2nd February the march towards Nizám Ghát was resumed along the left bank of the Tong river into which the Ithun falls at a point about a mile north of Kaladoi and some 3,000 feet below the village. The weather still continuing hopelessly bad, I was forced to abandon further survey operations after the second march from Kaladoi.

Nizám Ghát was reached on the 5th and here I found Sub-Surveyor Dharmu. The latter had come round from Grimbum and Bomjur after returning across the Máhu pass and had practically completed the survey of the outer slopes of the hills from Sajuba Peak to the Dibang (Tong) river at Nizám Ghát as well as of the outer hills on the right bank of the Dibang, and had worked up some distance towards Kaladoi so as to allow of his work joining with very little adjustment on to that done by myself. He had done this in face of considerable difficulties, as, not only had he been refused military escorts and been unable to obtain guides or interpreters, but had been obliged owing to military exigencies to give up the transport coolies who should have accompanied him, and had consequently been obliged to carry his own loads whenever he moved camp and himself and his *khalásis* to subsist on a very short scale of rations. From Nizám Ghát I accompanied the force back to the base at Sadiya, which place was reached on the 8th, leaving the sub-surveyor for one day at Bomjur to complete a portion of his work from that place.

At Sadiya the field force was demobilized on the 10th instant and the weather still remaining utterly unsuited to the conduct of any further survey operations, I called in the heliotropers from the Paropora station, examined and carefully checked the village lists, etc., with Mr. Needham and the Mishmi guides and returned into store the various articles of commissariat issued to the detachment, left Sadiya on 13th with all members of the detachment, reaching Dibrugarh on the following day. I left Dibrugarh again on the 16th and arrived in Silchar, travelling by steamer and rail, on the 22nd February.

The outcome of the expedition from a survey point of view has been the accomplishment of a topographical survey on the scale of 2 miles to the inch of 808 square miles of country. Much of this area (some 430 square miles) is of country hitherto unexplored, and it includes all that actually visited by the force and considerably more besides. It does not include, however, the survey of the stretch of flat country lying between the outer foot of the Mishmi hills and the Brahmaputra river and extending from the Sonpura Police outpost on the east to Nizám Ghát and the Dibang river on the west (mentioned in paragraph 2 of a note dated 20th October 1899 by Mr. Cotton on the scope of the expedition), for this tract of country, as previously mentioned, is to all intents and purposes dead level and covered throughout with a dense and uninhabited tropical forest, the only breaks in which occur at the river beds which traverse it from north to south. It would be possible to carry out the survey of such a tract of country in one of two ways: Either from the area itself by means of a net-work of traverses, theodolite or plane-table, or both combined; or else by means of a plane-table sketch survey from points along the high range overlooking it from the north. The former method would

entail an enormous amount of line-cutting and would consequently be excessively costly and very slow, and was quite beyond the scope of operations of a detachment of the size and composition of the one under my orders. The latter method however had been quite feasible provided the weather had permitted, and in the neighbourhood of Bomjur and Nizám Ghát was actually carried out. It was found though that at the time the surveyors were on the top of the hills overlooking this tract there was either a dense low-lying mist covering it or, as that rose under the influence of the sun, the hills themselves became enveloped in cloud which shut out everything from view. Still, at a more favourable time of year and given freedom of movement along the crest line of the outer range of hills (a condition which in the present instance did not obtain), there is no reason why this tract of country should not be surveyed in this way, as desired by Mr. Cotton, cheaply and with quite sufficient accuracy to meet all requirements to which it is likely the survey will ever be put.

Triangulation for the reasons already given was not possible, and this was the more unfortunate as not only could the position and height of the two undoubtedly very high snow mountains mentioned therein have been ascertained, but certain other snow peaks, evidently lying in the region of the head waters of the Dibang river, might also have been fixed and would probably have gone far to proving that this stream rises much further north and has a considerably larger drainage area than is shewn in the maps accompanying A. K.'s report or on the published small scale maps of this region. The enormous volume of water in this stream at the point where it was met with by the expedition, as compared with that of the Ithun river for instance, would seem to indicate the necessity for some such explanation to account for it

The nature of the country inhabited by the whole of the Mishmi tribe and by the Mithun section in particular is rugged and precipitous in the extreme. The line of advance selected entailed the passage of a pass 8,900 feet above sea level, the ascent to which was very steep and the descent from which into the valley of the Ithun, the main stream of the country, was almost impassable for laden coolies. The valleys throughout the country are very steep and narrow, in places amounting to gorges many thousand feet deep, and their slopes, up to heights of from 10,000 to 11,000 feet above sea level, are covered with a dense mixed forest above which on some of the hills are pines and on others a small species of bamboo which in the distance gives the hill the appearance of being covered with grass on the top. The top of the Sajuba Peak, 11,600 feet high, is covered with this bamboo growth. Above this again the hills are bare and covered with snow; in fact at the time of the expedition the snow line was down to between 8,000 and 9,000 feet above sea level on the outer range and considerably lower on the inner ones. At the head of the Ithun valley are large snow fields and some glaciers coming down from hills whose peaks range from 13,000 to 15,000 feet above sea level. To the north of the Ithun valley again, and separating it from the valley of the Ichu, is another range of bare snow-covered hills running up to altitudes of 13,000 and 14,000 feet.

The people are a thick set sturdy race of Mongolian type of feature and very dirty. Their weapons consist of a short *dao* which they chiefly use for cutting jungle, and bamboo bows and arrows, the latter of which they poison with the root of the aconite, of which the plant grows wild on the hills. Their war arrows have an iron barb, but the others which they use for hunting are simply of bamboo notched at the head. The men are clothed in a sort of kilt and a jacket of a coarse hempen material which is made in the villages; the women wear a jacket very similar to that worn by the men and very frequently short trousers, reaching to the knee, take the place of the kilt. The Mithun section wear their hair tied in a knot on the top of the head while the Midu crop theirs at about the level of the nape of the neck, and hence have received their name of Chulikata from the people of Assam with whom they have come in contact. Sociologically the tribe would appear to be in a decidedly backward state of development. There seems to be very little tribal authority, each village under its own headman being practically a law unto itself, and there is no trade in the country and consequently no currency of any sort.

The communications throughout are as bad as it is possible to imagine, consisting of the veriest foot paths, in many places passing along or up and down the faces of precipices on notched bamboos, knotted canes or roots of trees, and it is seldom possible to do a day's march without going up and down some 2,000 or 3,000 feet at least once, more often more than once.

The villages are built on the lower slopes of the hills, few of them being situated at elevations of more than 5,000 feet and are consequently all more or less near to the streams. The Mithun villages are all small, consisting as a rule of from 4 to 10 houses, but most of those of the Midu section are considerably larger than this. The former are built almost entirely of bamboo on rough wood standards and thatched with grass, but many of the Midu ones have a considerable amount of dressed timber in their construction and in some cases plank floors.

For purposes of cultivation the forest is "jhumed" in the same way as is the custom among other hill tribes in Assam and in Burma. These clearings are never at any great height above the villages.

The population is sparse, but the country could probably not support a denser one.

There are but few domestic animals in the country—dogs, pigs and the ubiquitous fowl being almost the only ones, though in some of the villages there are a few miyithna (gyal).

Opposition onthe part of the inhabitants to the progress of the expedition through the country there was practically none, as, although the path on the north side of the pass had been stockaded at one point and some 20 stone-shoots built commanding it, the stockade was not held nor were the stone-shoots released. Such Mithun villages as were visited and burned were in every case found to be deserted. The villages in most cases appear not to be built with a view to defence, though some of them were found with a bamboo stockade of sorts round them.

The hardships undergone by all members of the detachment in carrying out the survey of a country presenting the natural difficulties met with in the Mishmi country, in the middle of winter, with continued bad weather and on a scale of transport which not only precluded the taking of tents but also of any but the veriest necessities in the matter of warm clothing, blankets, etc., have been considerable, but, with the exception of the very heavy losses among the Khásia coolies supplied for the transport of the detachment, the health of all members throughout has been excellent. Should it ever be considered necessary to visit this country again for survey purposes an earlier period of the year (the end of October to the beginning or even the end of December) than that during which it was visited in the present case would probably allow of finer weather being experienced than was met with in this expedition.

Narrative Report by CAPTAIN C. H. D. RYDER, R.E., *on his work in Yunnan, season 1899-1900.*

During the previous field season the party under Captain Davies, Oxfordshire Light Infantry, had travelled over the greater part of Yunnan, but it required another season to complete the work. I had arranged with Captain Davies, while on leave in England, the routes we should each take to avoid, as far as possible, routes already surveyed. Captain Fraser, R.A., and Captain Rigby, Wiltshire Regiment, were also sent on to Yunnan, each accompanied by a Survey of India surveyor; Major Manifold, I.M.S., also came up from Bhamo to meet Captain Davies and myself at Atuntzŭ. The result of the season's work on the whole has been that practically every town in the province has now been visited and reported on, every important route and many others have been surveyed and reported on, my share being this year 1,400 miles of new routes, which I handed over to Captain Davies. Surveying was carried on on the ½-inch scale and a large area brought in, from which a very accurate, complete 16-mile map could be compiled, as well as the usual ½-inch sheets. On these latter, of course, many large blanks occur, and there remains still plenty of work to be done, but it would be advisable now to take any opportunity of pushing forward triangulation, as the work is necessarily up to now entirely of a reconnaissance nature.

We considered it advisable, in order not to draw any unnecessary attention to our work, not to carry on any triangulation and to march daily with a very occasional halt. The surveying consisted of a compass traverse, distances measured by a measuring wheel, plotted on a plane-table. Whenever some point was reached from which the surrounding country could be sketched, Captain Davies and I also took constant latitudes; and were also able to fix the positions of Yunnan-fu and Puerh-fu by telegraphic longtitudes, in addition to the places I had fixed with Captain Pirrie at Bhamo the previous season. Owing to my being appointed to the China Field Force, immediately on my arrival at Shanghai, I am unable to report on the fair maps of Yunnan.

I arrived in Rangoon early in November 1899, meeting Captain Davies there and travelling with him up to Myitkyina, it being our intention to enter Yunnan by two different routes from there. On our arrival, however, we found that the mules belonging to the Yunnan Company, which we were to use as transport, had been so reduced in number that there were only sufficient for Captain Davies, so as mules could not be hired locally, it being too early in the season, I came down by steamer to Bhamo, hired mules there and started on November 17th. My start was not very propitious, as I took the wrong road, finally got into the old road towards Myothit, but about 10 miles out we found a bridge washed away and an unfordable stream; we then had to turn off through the jungle and finally got into the new road being built by the Public Works Department and camped by the road side. My party consisted of a surveyor, three Gurkha Military Police, a *khalási*, two servants (one Indian and one Chinese), a Chinese interpreter, some four Chinese coolies for carrying instruments, and about 18 mules for carrying our baggage.

On November 18th we had an easy march to Myothit, and from there up to Momien we followed the same road as on the previous occasion On the 23rd I met Captain Davies and we travelled on to Momien together, where we were met by the Consul, Mr. Jamieson. Owing to his presence in the city the populace, who gave us so warm a reception last year, were quite friendly; this, however, was only temporary, as Major Manifold in the following February was mobbed. It is impossible to pass Momien without being struck by its suitability as a hill station for Burma; it is situated in a well cultivated plain, height 5,400 feet, good climate and good supplies, and a railway could be built without much difficulty from Bhamo. We halted a day here and left on November 27th, Captain Davies making for Puerh-fu and I for Yunnan-fu, agreeing to reach these places on 30th December in order to connect them by telegraphic longitude observations.

I struck away north-east across the plain and soon got amongst low hills crossing the two branches of the Shweli river next day by two good bridges,—one of wood, the

other a chain suspension bridge. It rained that day and I could see snow on the range ahead. This range we had to tackle next day, crossing it at 11,100 feet, the last 2,000 feet being through about one foot of snow, but luckily the path, though very steep, was very fair. At the top there is a temple inhabited by two old men, who as a work of merit, supply all travellers with a cup of hot tea and a warm by the fire,—very welcome as the cold was intense, thick icicles hanging from the caves of the temple as thick as my arm. There had been four of these old men: two others, who had died, presented each traveller —one with a bowl of rice, the other with a pair of grass sandals. Well-to-do men, I was told, they were, but they had given up an easy life and the pleasures of this world *in* order to do these simple acts of kindness, for which we, like many other travellers, were exceedingly grateful. Very glad we were to hurry down the other side. Lately arrived from the plains of Burma no one enjoyed the cold, though the view was magnificent; we could see the Salween in the valley below, but it was a long way off yet; two camps before we crossed it. At one we saw some barking deer, and the Gurkhas shot one. The Salween valley is not pleasant, too hot; we crossed in a big punt which took us over in three trips and had a very hot climb up the bare hills on the other side. The valley is mostly peopled by Shans, the Chinese wisely preferring the higher and healthier hills. We had some very hilly marching then, marching all day but only going 12 miles or so a day, crossing the Salween-Mekong watershed in a *small* cultivated plain at about 7,000 feet, but immediately afterwards climbing to 11,800 feet before dropping down into the main valley by a very bad rocky path. That day the path was so bad that my baggage never turned up; however, I was not uncomfortable in a Chinese house on Chinese food. Next day December 6th, we crossed the Mekong by a very fine chain suspension bridge at Fei-lung-chiao and here came on to Prince Henry of Orleans' route, which we followed for several days. December 7th, we reached the small town of Yun-lung-chou, where I was received in style with a band and soldiers, a little boy heading the procession as lictor, with a whip to keep the crowd back. In the neighbourhood there are salt wells and we had met many mules and coolies carrying the salt away down towards Yung-chang-fu.

Another five days' march continually up or down hill brought us to the small town of Teng-chuan-chou at the north end of the Tali-fu lake. Mr. Grabame, of the China Inland Mission at Tali-fu, came out to meet me. After a day's halt for shooting amongst the duck, which were in hundreds over the somewhat marshy plain, I skirted the northern and eastern sides of the lake for a couple of days and then struck eastwards. The country from here onwards to Yunnan-fu does not present any remarkable features. The streams flow either towards the Yangtze or to the south to the Red river—several fair-sized plains are passed, and the marching is hard, as there are many steep ascents and descents—finally after a march of 23 miles we reached Yunnan-fu. We had followed paths to the north of the main road through unsurveyed country *viâ* Pin-chuan-chou, Gei-yen-ching, Tayao-hsien, Ting-yuen-hsien, Fumin-hsien—all fair-sized towns.

At Yunnan-fu I remained eight days, obtaining telegraphic connection with Captain Davies at Puerh-fu and failing to connect with Major Fleming at Bhamo. During my stay I received much kindness from the missionaries, whose houses were all burnt down in the following June, they themselves having to retire to Tong-king.

January 8th, owing to my having stayed at Yunnan-fu longer than I had anticipated I now had some very long marches to meet Davies at I-men-hsien, but the country hereabouts is much flatter. We passed through 9 towns in the 10 days, and as each town means a plain, marching was much easier. I had also discharged my mules and engaged a new lot. The first day I went back on the main Tali-fu road to Anning-chou. On the 9th we followed up the river flowing from the lake for 12 miles to its outlet at Hai-kou; here I was urgently requested to halt, but pushed on over the downs bordering the lake to Kuei-yang-hsien, arriving there long after dark and having great difficulty in getting quarters in a temple. Another day led us round the south end of the lake. We then had a range to cross on a bitterly cold day in a blizzard with a long descent to the very rich plain of Cheng-chiang-fu situated at the north end of a very fine lake, surrounded by mountains. The path then led round the shore of the lake through lovely scenery for 10 miles and gradually ascended over a range, two long marches, 40 miles in all, through rather poor country, bringing us to the small town of Tingchou; from here we struck west again to Tunghaionyet another lake,—a very busy little town with a telegraph office. Two days more to Sin-hsing-chou, a prosperous plain through which the French railway line will run, and then two very long tiring marches of 48 miles in all brought us to I-men-hsien, where I found Captain Davies had arrived the day previous. Two days' halt here were very welcome, after which we separated, I going to Tsu-hsiung-fu, which I reached in three days, while Captain Davies went to Yunnan-fu. We were very fortunate the same evening in obtaining telegraphic communication, and thus at last getting the longitude of Yunnan-fu, as Tsu-hsiung-fu was connected with Bhamo last year.

Another five days' north-east to Wuting-chou where Captain Davies and I had arranged to meet for the Chinese new year, entailing a two days' halt, it being very difficult to get any Chinese to work or march at this their great holiday time. We then once more separated to meet again two months hence at Atun tzŭ; and I struck across by a little known and very bad path for Tung-chuan-fu, which I reached on 9th February after 8 days' march. In one place the path was so bad on the face of the cliff that the mules had to be unloaded and baggage carried across. When I had got half-way across the

bad bit myself I met a Chinese woman stumping across, and as she did not seem to mind the *khud* below, I had to look much happier than I felt. We had been coming through some rather lower valleys, but the day we reached Tung-chuan-fu was bitterly cold; and I was very glad to get into the hospitable house of Mr. and Mrs. Grist, missionaries. Next day it was snowing hard, and with the thermometer below freezing point at mid-day I decided to halt.

From Tung-chuan-fu to Chaotung-fu we followed the main trade route for five stages; long marches with a good deal of up and down hill. It is easy to understand that a traveller seeing the main trade route with such very steep gradients, would come away under the erroneous impression that railways were an impossibility in such a country.

From Chaotung-fu we turned south-west and crossed the Yangtze at Chiao-chia-ting, but this distance, though short on the map, took us 7 days. The route I had heard of was only a coolie path, travelled over by Mr. Baber; we had to cross a range over 10,000 feet in height in the snow and then drop down to the river at 2,000 feet; this sudden descent made us feel the heat of the valley.

Another 4 days' skirting the Solo country, a few villages of which people I came across, and we reach Hui-li-chou—a very prosperous town in Ssŭ-chuan. I here found a difficulty about getting on; some Solos were up in rebellion on the path I wished to follow, and I was informed that it was quite impossible that I should go that way; however, on sending a message to the Magistrate that I should go the way I mentioned, the following day I was provided with a stronger escort, and started on 2nd March. We had two good sized rivers to cross—the Anning river and the Yalung; the latter much the same size as the Yangtze. From here the path gradually got worse, it was only a coolie track, and it was with the utmost difficulty we could get the mules along. Gradually rising we finally reached the plateau on which is situated the town of Yen-yuan-hsien; here I got a go of fever, which necessitated a day's halt, which my mule men took advantage of by getting into a row with some local men. This took place about midnight, and feeling somewhat annoyed I got up, saw about 20 quarrelling Chinese in the vineyard, and told one of my Gurkhas to turn them out; into the middle of them he went with a short stick and in half a minute they had disappeared, leaving one of their number senseless in the pig's trough; then the Gurkha thinking he had been too violent in his methods, picked the man up and I heard him for about half an hour afterwards alternately trying to persuade him in broken Chinese to drink water and recover and then cursing him black and blue for coming and disturbing his *sahib's* rest.

I now wished to go on to Yung-ling, a Mosso State, but the officials were unwilling to allow me to go: the road was full of robbers, nobody knew the way and finally nobody had heard of the place. My day's halt, however, got me the necessary guide, an escort of two men came two marches with me, and then returned, not liking the country. We left on March 11th and did a short level march to Mokoyenching, some salt wells; the height of this plain was 8,800 feet, and it took another long march to get out of it. That day was hazy, the only day in which surveying was in any way interfered with by that bugbear of any surveyor in Burma. We then climbed a fine range at 13,000 feet and gradually descending the following day to a small river at 7,000 feet. About this time I found great difficulty in getting over the marches and surveying, as I had a go of tonsilitis, and for about three days a most agonising form of itch, enough to drive one mad, as my feet and hands swelled up to half as large again as at ordinary times; however, another two long marches brought us to Yunzuing, a mere village in a large plain, but the capital of a Mosso State. The last march was in most lovely country, height 10,000 feet, and half the day we skirted the edge of a large lake. A day's halt put me all right. The people at Yunzuing were very pleasant. A young Lama guided me on to Chung-tien, the next large place, 5 days' distant. We had now got into most fascinating country, the scenery of a Tibetan nature, height from 10,000 to 14,000 feet, except for one drop down to the Yangtze where it makes a great bend to the north. This is not marked on any map, but Mr. Amundsen, a Swedish missionary, had the previous year noted this bend in a journey from Ta-tzien-lu to Talifu. The 22nd March was a stiff day, 20 miles including a climb of 4,000 feet, and late in the evening we got into a long cultivated valley, the inhabitants of which were most inhospitable and turned us away from three houses. We finally found one without an owner and into this we settled, lit a fire and waited for the baggage; presently the owner turned up and rudely said "get out;" however, I was too tired to move, and so we offered him a seat by his own fireside and soon became friends, on his finding he could not get rid of us. He then proceeded to sell us fowls, etc, at an exorbitant price. These people here, Tibetans of sorts, are not hospitable. They have one invariable answer to a request for lodging "there's an excellent place,—will just suit you—about half a mile on." The unfortunate traveller who took the villager at his word would find himself sleeping the night out on the bare hills.

We were now well into the region of *yaks* and Lamas and at Chungtien, where the population is half Chinese, we excited that intense and persistent curiosity which only the Chinese possess to so great a degree: the roofs of the neighbouring houses, the courtyards, my own verandah, every conceivable place was covered with spectators from morning to night. However, I knew that in a few days I should have the pleasure of European companionship again. There was plenty of snow anywhere over 13,000 feet, but three marches brought us down to the Yangtze at Poung-dze-la, the head man of which place was exceptionally polite. I was told it was three marches to Atuntzŭ and

left on March 27th ; but next day we got into the snow and only did 6 miles, the following day 2 miles. I then sent back the mules for more food and halted in a most uncomfortable place on the hillside at about 13,000 feet. I had agreed while in England with Captain Davies that I should reach Atuntzŭ on March 28th and he on March 26th. This unfortunate snow had blocked me. I thought it would be best to go in to see him and try to arrange for *yaks* to bring my baggage over the pass ; so on the 30th started at five o'clock with one Chinese and one Tibetan. There were three passes to cross, with a drop of 1,000 feet between each. The snow soon got soft, there was nowhere less than three feet, often 10 feet or more, and with only one halt of 15 minutes we finally got out of the snow at 2 P.M.—9 hours to do 12 miles ; we then had another 10 miles to do and finally to breast a long gradual slope up to Atuntzŭ. On arrival after dark we found that Captain Davies had not arrived, but I luckily found a small inn, the owner of which, a Chinese with his Tibetan wife, were most obliging, and very soon I was resting with a nice meal of fried eggs, tea and Tibetan bread, on the floor before me. Both my men were suffering from snow blindness, so I decided to halt next day and then returned to my camp, but in two marches this time, camping out just below the snow with a couple of blankets. Luckily it was a fine night. Next morning we started early (3-30), and groped our way up in the dark ; the snow was hard, however, and we made very light of the passes this time, finally reaching camp about 11. I had just had my bath when I heard shouts that Captain Davies was coming up the hill and very soon he arrived. He too had been delayed by the snow and been obliged to come south on to my road. A large caravan of 100 or more mules passed us, and with the help of the path trodden down by them we managed to get across the passes next day. My mules got through all right, but Davies' we finally had to leave, about 5 P.M., a mile short of the last pass after hours of hard work reloading mules and picking them out of the snow. They passed a wretched night, it snowed all night, one mule died and the rest struggled in about mid-day the following day, we then packed up and pushed on to Atuntzŭ that night, April 4th. We then waited for Major Manifold, who arrived on the 6th, his baggage coming in next day.

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PHOTOGRAPHIC AND LITHOGRAPHIC OFFICE, CALCUTTA.

Extract from the Narrative Report of MR. T. A. POPE, *Assistant Surveyor-General, season 1899-1900.*

Direct Zinc-Printing Section.—During the hot weather months, Mr. Vandyke, Foreman Litho. Printer, occupied his spare time in working out a new process for the reproduction of drawings by a method of direct printing upon zinc. This has proved entirely successful—so much so that by the end of the year a new section had been organized which is turning out a considerable quantity of work in much less time and at a much lower cost than it could be done either by photozincography or lithography. The process is unquestionably novel and is entirely the invention of Mr. Vandyke, who has been granted a patent for it in this country.

It may briefly be described as a method of obtaining an image in transfer ink on a zinc plate direct from a black and white original, without the intervention of a negative. It consists of five separate operations, *viz* :—

(1).—Coating the plate,
(2).—Exposure to sunlight,
(3).—Development of a negative image,
(4).—Inking of the plate, and
(5).—Development of a positive image.

After the fifth operation the plate is similar in all respects to one which has been produced by the ordinary method of photozincography, and can be etched and printed from in the usual manner.

Any subject drawn or printed in black on paper or tracing cloth can be dealt with, provided a printing frame large enough to contain it is available The original must, of course, be drawn on the scale of reproduction. There must be no slips of paper pasted upon it, as the exposure to light must be timed with exactitude, and the extra thickness of the pasted slips requires a double exposure; but with this proviso any original, no matter how discoloured or dirty, will, with care, give good results. If the drawing be creased or folded it should be passed through a press before being placed in the frame, or contact may be imperfect.

(1).—*Coating the plate.*—Thin zinc plates can alone be used for this process, and it is immaterial whether they are polished or grained. The sensitising solution consists of—

Fish Glue	1 oz.
Gelatine	60 grains.
Bichromate of ammonium	45 grains.
Water	12 oz.

Some trouble was experienced in finding the proper consistency for this solution. If made too thick it is impossible to get an even coating, but after many trials the above amount of water added to the fish glue was found to give the best results. The best method of coating the plate is to flood it with a thin coat of the solution and place it in a whirler, so as to obtain the thinnest possible layer of the sensitised glue. Fair results were obtained by rubbing the plate over with a linen pad charged with the solution and squeezing off the superfluous liquid, but this method, except in the case of small plates, is apt to give rise to streaks, which cause trouble. When large plates are being used the coating can best be laid on by flowing the solution over them while they are wet and drying them by heat over a support in a drying box. When dry they are ready for exposure.

(2).—*Exposure.*—The subject for reproduction is laid in the printing frame face upwards and the plate is placed in position upon it, with the sensitve surface in contact with the face of the subject. This must be done in a weak yellow light. Perfect contact is essential. It is a good plan to place over the zinc plate a sheet of India rubber, and over that again a sheet of glass and a pad of felt. The exposure varies greatly according to the light and the thickness of the original; for a tracing, half a minute in the sun or three minutes in the shade has been found sufficient; for a drawing on thick paper it may amount to from three to five minutes in strong sunlight. The latter exposure was found sufficient for original cadastral sheets drawn on the 1-inch squares and in their usual dirty conditon.

(3).—*Development of the negative image.*—The action of light through the subject hardens the bichromatised fish-glue and renders it insoluble in cold water. It is possible, therefore, by the action of water to dissolve away the unaltered glue which has been protected from light by the lines of the drawing, in much the same manner as a carbon transfer is developed after it has been exposed and inked up. The development must be carefully performed, otherwise some portions of the glue may be removed from the ground. It should first be soaked for a few minutes in cold water, after which development can be carried on by spraying the plate under a rose. Very light

rubbing with a tuft of cotton wool may be resorted to, and, if the exposure has been sufficient to thoroughly harden the glue, will help to clear the lines without affecting the ground. But with a perfectly timed exposure it is possible to clear away all the soft glue from the lines by merely directing a stream of water upon them. When fully developed, the lines of the drawing should stand out in clean zinc, sharp and distinct. To facilitate development the plate may be stained with an aniline dye, which enables the operation to be watched while in progress. Any defects in the background caused by the accidental removal of the glue therefrom, or by yellow stains or black spots on the original, can be remedied at this stage by painting them over with gum, which will prevent them from appearing on the finished plate. A negative image of the original has thus been obtained upon the plate which it is necessary to convert into a positive one.

(4).—*Inking of the plate.*—To effect this, the plate when dry is inked up, the ink used being made up of 4 parts of bitumen, I part of lithographic writing ink, I part of litho. printing ink and 1 part of Burgundy pitch, thinned down with turpentine, and is applied by means of a roller, or rubbed over the plate with a pad. The lines are now covered up with ink, while the background still remains covered with the hardened glue, having a layer of ink over it.

(5).—*Development of the positive image.*—The next operation is to get rid of this glue, leaving the ink-covered lines intact and sharp, and this is effected by the use of a very weak solution of hydrochloric acid (½ oz. of pure acid to I gallon of water) in which the plate is immersed. This softens the glue without attacking the zinc, and the glue can then be entirely removed from the background by light rubbing with a piece of flannel. The ink-coverd lines are not affected by this treatment. In order to ensure the plate rolling up clean and free from scum it is now necessary to rub it over with powdered carbonate of magnesia moistened with a little water, which removes any remaining traces of the glue. The plate is then dried, after which any defects can be remedied in the usual way. It can then be etched and printed from.

The advantages of the process are obvious. In the first place it is considerably cheaper than the ordinary method, as it does away entirely with the necessity for negatives and transfers. For the same reason it is much more expeditious. It is easily possible to prepare a plate in half an hour, and a considerable number can be prepared in a day, the time usually occupied by the old method being three days, one for the negative, one for the transfer, and one for transferring to zinc and proving. The results obtained by the new method are superior in sharpness to those yielded by the usual process, as there is no squashing out of the ink as there is when a paper transfer is put down on zinc in a press, to which the slight coarseness of all photozincographed prints is due. Finally all distortion is effectually prevented, and the process should prove particulary useful in the preparation of colour plates, as it obviates the possibility of faulty registration.

The invention of this process has rendered it possible for the office to undertake the reproduction of a large number of cadastral sheets of the Bengal surveys, which, owing to the heavy cost involved, and to the fact that the cadastral establishment of the office was already supplied with work for some years to come, could not otherwise have been undertaken. Various estimates have been prepared for the execution of this work by a special establishment to be entertained and trained for the purpose, or for its reproduction by the cyanotype process, but in every case the cost was heavier than the Bengal Government felt justified in incurring. By utilising Mr. Vandyke's process I have been able to furnish copies of these maps at the very low rate of Rs. 1-3 per ten copies of each sheet reproduced, or about one-ninth of the regular cadastral rate. This was at once accepted and the reproduction of a first instalment of 8,300 sheets of the Orissa cadastral survey has been sanctioned, and it is understood that about 20,000 additional sheets will probably be required when the first lot are completed. Since the beginning of September 1900, when the section first began regular work, we have been reproducing these maps at the rate of 25 plates prepared and 250 copies printed per day, the original tracings being prepared and sent in daily by the Bengal Drawing Office. The staff engaged on this work is a temporary one, and was taken partly from the Negative section and partly by engaging new hands. It is paid for out of the money received from the Bengal Government in payment for the work, and the men from the Negative section employed on it have been seconded in their posts in the amalgamated list. The section has been placed in the charge of Mr. A. Francis of the Negative section, who now manages it without any assistance from Mr Vandyke. During the month of September 463 plates were prepared by this process, of which 458 were Bengal cadastral maps and five were miscellaneous extra-departmental jobs.

The strength of the section as at present constituted is hardly more than sufficient to deal with the work for the Bengal Government. As there is a good deal of work constantly coming in, which might be dealt with in the same way (such as railway progress sections and other similar plans and diagrams drawn on tracing paper or cloth), I hope ere long to be able to strengthen it somewhat, in order that the low rates chargeable for this work may be made more generally available.

TRIGONOMETRICAL BRANCH OFFICE, DEHRA DÚN.

Extracts from the Narrative Report of MR. J. ECCLES, M.A., *Superintendent, 2nd grade, in charge Computing Party, season 1899-1900.*

Shortly after Major Burrard's return experiments were made with a view to seeing what use could be made of photo-surveying in the department. The instrument used was a Bridges-Lee's surveying camera and the experiment was conducted so as to see with how few camera stations the survey could be completed. This was found to be a mistake, as it made the plotting more difficult than it need have been. The result as a survey was good, but it took a good deal longer to plot than it would have done to plane-table the area. The camera was again used for small scale work by Lieutenants Tandy and Hirst on the Kalunga Hill and again the work was good but the plotting was very laborious owing to the difficulty of identifying the features on the various negatives. The camera has two defects, the first being that the tangent scale is not correct, and the second that there is no means of elevating or depressing the camera except by the foot screws. The former is not very important but the latter might spoil a round in hilly country where one was anxious to get down to the bottom of a valley, such as, say, the Aglar valley. The camera might easily be slung on Y's with a small arc attached to read the angles of elevation or depression. On the whole the experiments point to the conclusion that the photo-theodolite will be of very great use as an auxiliary to the plane-table (specially in very mountainous country) but that it can never supersede it.

Another interesting experiment is proceeding, and will shortly be sufficiently advanced to publish. This is the determination of the change in the length of a levelling staff due to humidity and temperature. Unfortunately the experiment was interrupted for six or eight weeks as the microscopes were required for the base line measurement.

In the Photozincographic section an attempt was made to introduce the process of printing directly on to zinc from the negative instead of the usual way by means of transfer paper: the attempt was very successful and as soon as the reversing mirror, which has been ordered from England arrives, the process will be employed for all suitably sized subjects.

Mean Monthly Readings of Earth Thermometers.

Depth in feet of thermometer bulbs below surface of ground.	Year.	October.	November.	December.	January.	February.	March.	April.	May.	June.	July.	August.	September.
25·6.	1899-1900	76·90	77·03	76·91	76·70	75·88	74·50	73·80	73·80	74·32	75·21	76·53	77·98
	Mean, 1881-99	76·92	76·94	76·76	76·19	75·65	75·02	74·44	74·14	74·10	74·45	75·70	76·68
12·8.	1899-1900	79·24	78·48	76·92	75·14	73·01	71·72	71·93	73·55	75·90	78·37	79·57	80·13
	Mean, 1881-99	79·44	78·16	76·02	73·74	71·74	70·84	71·40	73·20	75·29	77·31	79·18	79·70
6·4.	1899-1900	80·52	76·86	72·68	68·53	65·83	67·70	72·07	76·36	80·51	81·99	81·86	81·06
	Mean, 1881-99	79·73	75·90	71·31	67·32	65·64	67·14	71·65	76·96	80·41	81·40	81·50	81·24
3·2.	1899-1900	80·27	73 88	67·86	63·01	62·01	68·18	74·73	82·53	86·30	84·28	83·01	80·86
	Mean, 1881-99	78·29	71·85	65·68	61·96	61·41	65·83	75·71	82·34	84·86	83·35	82·17	81·79
1·1.	1899-1900	79·09	70·75	62·40	57·84	59·72	69·75	76·36	87·18	90·30	84·72	83·34	79·88
	Mean, 1881-99	76·36	67·74	60·18	57·37	58·82	67·76	78·89	86·29	87·91	84·11	82·44	81·65
Thermometer in shade	1899-1900	83·10	75·14	69·59	63·06	66·17	82·01	84·78	90·62	93·04	83·60	81·24	78·97
	Mean, 1881-99	80·59	73·34	67·49	64·26	66·96	78·80	89·74	93·82	90·00	82·43	80·80	82·64

Synopsis of the Results of the Monthly Magnetic Observations taken at the Trigonometrical Branch Office, Dehra Dún. The measures of Intensity are all expressed in C. G. S. units.

Year and Month.	Magnetic Elements.			Remarks.
	Declination, East.	Horizontal Intensity.	Dip, North.	Total Intensity.	
1897.	° ′ ″		° ′		
January	2 49 39	0·33,659	42 40·2	0·45,778	With Unifilar Magnetometer No. 19 and Dip Circle No. 43.
February	48 42	·33,730	42·1	·45,898	
April	48 17	·31,901*	41·0	·43,396*	
May	50 4	·33,667	46·5	·45,866	
June	48 15	·34,032	50·5	·46,413	
July	48 42	·33,646	38·8	·45,743	
August	45 22*	·33,656	45·6	·45,840	
September	48 10	·33,695	45·2	·45,888	
October	49 27	·33,629	46·2	·45,824	
November	50 33	·33,627	44·4	·45,786	
December	48 24	·33,667	48·0	·45,884	
1898.					
January	2 50 45	0·33,757	42 48·0	0·46,007	
February	50 1	·33,605	48·2	·45,802	
March	51 12	·33,665	46·8	·45,867	
April	50 32	·33,660	52·9	·45,936	
May	51 11	·33,842	51·9	·46,173	
June	51 14	·33,514	48·3	·45,721	
July	54 24	·33,271	52·1	·45,396	
August	48 24	·33,714	48·5	·45,955	
September	51 32	·33,569	52·8	·45,811	
October	49 30	·33,589	52·9	·45,839	
November	48 37	·33,389	47·9	·45,505	
December	51 14	·33,673	51·6	·45,938	
1899.					
January	2 50 24	0·33,640	42 51·0	0·45,884	
February	50 23	·33,617	51·9	·45,864	
March	50 28	·33,700	52·1	·45,981	
April	51 10	·33,616	52·1	·45,865	
May	48 41	·33,801	54·7	·46,150	
June	48 55	·32,821	49·4	·44,748	
July	50 14	·33,742	52·6	·46,044	
August	48 46	·33,786	53·0	·46,109	
September	47 51	·33,566	53·5	·45,815	
October	49 6	·33,633	53·5	·45,906	
November	49 6	·33,623	53·5	·45,892	
December	47 47	·33,560	54·5	·45,818	
1900.					
January	2 48 46	0·33,580	42 53·9	0·45,838	
February	48 36	·33,558	55·0	·45,822	
March	48 59	·33,471	54·4	·45,696	
April	50 15	·33,669	51·2	·45,927	
May	48 28	·33,564	53·8	·45,816	
June	48 1	·33,554	53·5	·45,798	
July	49 13	·33,704	54·1	·46,011	
August	48 53	·33,612	54·0	·45,884	
September	47 31	·33,582	55·1	·45,857	

* Observations unsatisfactory.

1901.

File No. 81 of 1901.

GOVERNMENT OF INDIA.

Serial No. 2.

DEPARTMENT OF REVENUE AND AGRICULTURE.

LAND-SURVEYS.

RESOLUTION.

No. 4—81-2.

Dated Simla, the 10th September 1901.

SUBJECT.

Reviews the General Report on the operations of the Survey of India Department for the year 1899-1900.

G. C. Press, Simla.—No. 730 R. & A. D.—12-9-1901.—660.

No. 4—81-2.

Extract from the Proceedings of the Government of India, in the Department of Revenue and Agriculture (Land-Surveys); dated Simla, the 10th September 1901.

READ—

The General Report on the operations of the Survey of India Department during the year 1899-1900.

RESOLUTION.

Field operations were carried on by one double and fifteen ordinary parties and four detachments: of these, one was employed on trigonometrical, eight on topographical surveys; one double and one ordinary party on cadastral surveys; four detachments on traverse surveys and three parties on special geodetic investigations. In addition, special surveys of Government forests were carried out by the Forest Survey Branch, while in the North-Western Provinces and Oudh traverse and cadastral surveys were continued by local agency under the general supervision of the Deputy Surveyor General. The total outturn of detail survey during the year amounted to 149,677 square miles, which included 120,259 square miles of reconnaissance surveys on the $\frac{1}{4}$ inch and smaller scales on the North-east and North-west frontiers. The total area of rigorous surveys on all scales was 29,418 square miles. The total area triangulated was 41,110 square miles, including 16,009 square miles triangulated in connection with reconnaissance surveys. The total area traversed for cadastral purposes was 5,850 square miles.

2. The Government of India notice with interest the large addition to the geographical knowledge of Yunnan and the North Eastern frontier which has resulted from the reconnaissance work carried out by Captain Ryder, by the party under Major Renny-Tailyour which was attached to the Burma-China Boundary Commission, and by the late Captain Hare. Reconnaissance surveys on the North Western frontier and in Kashmir also yielded results of considerable value.

3. Of the eight parties engaged on Topographical operations, four were employed in the hills of Burma and one on the Lushai Hills of Assam. The results obtained are of value, but the Government of India consider that there are objections to the concentration of so large a portion of the operations in these remote tracts when maps are actually wanting for many of the thickly populated districts of the North-Western Provinces. They are therefore glad to learn that the Surveyor-General has in contemplation the amalgamation of two of the Burma parties and the transfer of the Assam party to the Ganges-Jumna Doab.

4. Cadastral survey operations were conducted in the North-Western Provinces and Oudh, Bengal and Burma. The Government of India notice with satisfaction the efficiency and economy which have characterized the surveys carried out under the orders of the North-Western Provinces Government by the survey officers who have been deputed to the charge of these provincial operations, and they trust that good results will ensue from the recent amalgamation, under the control of a single officer, of the various establishments employed on traverse and cadastral surveys and map-drawing. On the other hand, they have observed with regret the high cost of the cadastral survey of the Darbhanga district in Bengal. In view of the possible extension of the Bengal cadastral surveys, they consider that it is of much importance that the operations should be so conducted as to be as light a burden on the people as possible, and they trust that the importance of economy will be borne in mind.

5. During the year, forest surveys were carried out in Madras, Bombay, Burma, the Central Provinces, Bengal and the Punjab. The total outturn of these surveys, executed on various scales, during the year amounted to 4,723 square miles, of which 2,421 square miles were disposed of by the Forest Survey Branch. In this connection, again the Government of India desire to lay stress on the importance of economy. Much of the forest area under survey is of very little value as a source of timber supply, and it is desirable that the expenditure incurred in mapping it should be kept within moderate limits. Recent years have shown a material reduction in cost rate, and the expenditure incurred in the Central Provinces forest surveys was generally moderate, though it is not clear why they were so much more expensive in Saugor than elsewhere. It is observed that certain of the Bombay forest surveys were effected on very large scales, at an unusually high cost rate, and the Government of India are disposed to doubt whether, except in very exceptional cases, such large scale forest maps are necessary, and are of opinion that all requirements could be generally met by separately plotting the outside boundary line where very intricate, and using the 4-inch scale for the mapping of interior details. In connection with forest surveys the Government of India desire to place on record their high appreciation of the services rendered by Mr. W. H. Reynolds, who retired on pension during the year.

6. Valuable scientific observations were effected in the determination of latitudes, and the Government of India have perused with interest Captain Lenox-Conyngham's discussion of the results obtained. Tidal observations were continued as usual. At the instance of the Royal Society, arrangements have now been completed for the inauguration of a Magnetic Survey of India. The execution of the work will be carried out jointly by the Survey of India and the Meteorological Departments.

7. A note by Colonel Gore is appended to the report on the question of revising obsolete or incorrect topographical sheets. The matter is being separately considered by the Government of India.

8. At the Head Quarter Offices much useful work has been accomplished in the revision and publication of maps. An invention made by Mr. Vandyke of the Photo-Litho Office, which is described in the Report and for which the inventor has been awarded a bonus of Rs. 10,000, promises to be of very great value in facilitating the reproduction of field maps. Important reforms have recently been sanctioned in the Mathematical Instrument Office with a view to effecting the gradual introduction of a system of payment by piece-work, which it is trusted will result in increased efficiency and economy

9. The report is the first submitted by Colonel Gore who took charge of the office of Surveyor-General on the retirement of Major-General C. Strahan. The Government of India desire to acknowledge the efficient way in which the Department as a whole has worked under his able and effective administration.

ORDER.—Ordered that the above Resolution be forwarded to the Surveyor-General of India, the Inspector-General of Forests, the Local Governments and Administrations noted on the margin and to the Foreign, Military, and Public Works Departments.

Madras.
Bombay.
Bengal.
North-Western Provinces and Oudh.
Punjab.
Burma.
Central Provinces.
Assam.
Coorg.
Bihar.

Ordered also, that the Resolution be published in the Supplement to the Gazette of India.

[True Extract.]

J. B. FULLER,

Secretary to the Govt. of India.

Photogravure. Survey of India Offices, Calcutta, February 1902.

FERRY ON THE INDUS AT CHILAS.

Enlarged from a negative by Capt. G. A. Beazeley, R.E.

GENERAL REPORT

ON THE

OPERATIONS

OF THE

Survey of India

ADMINISTERED UNDER

THE GOVERNMENT OF INDIA

DURING

1900-1901.

LIBRARY OF THE BOMBAY BRANCH OF THE ROYAL ASIATIC SOCIETY

PREPARED UNDER THE DIRECTION OF

COLONEL ST. G. C. GORE, R.E.,

SURVEYOR-GENERAL OF INDIA.

CALCUTTA:

OFFICE OF THE SUPERINTENDENT OF GOVERNMENT PRINTING, INDIA.

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INDIA
BAY OF BENGAL
INDIAN OCEAN
REFERENCE TO COLOURS

BAY OF BENGAL
INDEX CHART
OF THE
GREAT TRIGONOMETRICAL SURVEY
OF
INDIA

GENERAL REPORT

ON THE

Operations of the Survey of India

DURING THE SURVEY YEAR

1900-1901.

PART I.

SUMMARY.

ADMINISTRATION.

Under the orders of the Government of India the present report, which deals with the operations of the Department for the survey year ending 30th September 1901, has been considerably curtailed and somewhat altered in form. Part III which hitherto dealt with the work of the several Head-Quarters offices is omitted, and the salient facts connected with these offices are incorporated in Part I. The number of Index maps illustrating the reports of the several parties is similarly reduced; a diagram indicates the progress of the forest surveys, and provincial index maps take the place of a large number of small indexes. The extracts from the narrative reports of the officers in charge of parties will no longer be printed as appendices to this report, but will be published separately in the "Professional Papers" of the Survey of India.

2. Colonel St. G. C. Gore, R.E., Surveyor-General, directed the general administration of the department and also superintended the Topographical Branch throughout the year.

Colonel J. R. Hobday, I.S.C., Deputy Surveyor-General, held charge of the Revenue Branch up to 30th March 1901, when he proceeded on leave and Major F. B. Longe, R.E., was appointed to officiate as Deputy Surveyor-General.

Major S. G. Burrard, R.E., superintended the Trigonometrical Branch throughout the year.

The office of Superintendent, Provincial Surveys, Bengal, was held by Major G. B. Hodgson, I.S.C., up to the 8th October 1900, and by Captain A. Mears, I.S.C., up to 5th November, when Captain R. T. Crichton, I.S.C., returned from leave and resumed charge from the following day.

The office of Superintendent of Provincial Surveys, North-Western Provinces and Oudh, was held by Mr. G. B. Scott up to 31st July 1901, when he retired and Captain W. M. Coldstream, R.E., succeeded him in the post.

The post of Superintendent, Forest Surveys, held for many years by Mr. W. H. Reynolds, was on his retirement on 30th September 1900 conferred on Major P. J. Gordon, I. S. C., who has carried on the administration throughout the year.

Inspection tours of the Administrative Officers.

3. The Surveyor-General proceeded on a tour of inspection to Burma on the 22nd February 1901, and after inspecting the operations of Nos. 3 and 10 Parties, and conferring with the Director of Land Records and Agriculture on the question of the maintenance of, and the information required to be shown on, the topographical maps, returned to Calcutta on the 21st March. On the 11th April he left for Simla, but on his way visited the Central Provinces Drawing Office at Jubbulpore and the Trigonometrical Branch Office at Dehra Dún, arriving at Simla on the 1st May. During his stay at Simla he visited the recess office of No. 18 Party, and settled preliminaries for its reorganization and amalgamation with the Punjab Traverse Detachment,

with a view to taking up survey operations in the plains of Punjab. He left Simla on the 30th July for Dehra Dún where he again visited the Trigonometrical Branch Office and the office of the Superintendent, Forest Surveys, Bengal Presidency. He also visited the magnetic observatory building which had just been completed. On the 5th August he proceeded to Mussooree where he inspected the recess office of No. 15 Party and the North-Western Frontier Drawing Office. He also visited there the offices of No. 4 Party and of the Punjab Traverse Detachment, and returned to Calcutta on the 14th August. On the 20th August he again left Calcutta and proceeded to Bangalore where he inspected the recess offices of Nos. 10, 11 and 21 Parties and visited the offices of Nos. 3, and 9 and 19 Parties; from there he proceeded to Kodaikánal Observatory, and thence to Poona where he inspected No. 17 Party. On the 16th September he left for Naini Tal, where he inspected the office of the Superintendent, Provincial Surveys, North-Western Provinces and Oudh, and also the Drawing Office attached thereto, and returned to Calcutta on the 26th September 1901.

4. Colonel Hobday inspected No. 4 Party and the Punjab Detachment at their recess quarters at Mussooree in October 1900. On November 17th he proceeded to Jubbulpore and inspected the Central Provinces Detachment, returning to Calcutta on the 20th idem. In January 1901 he inspected the Punjab Detachment in the field in the Montgomery district, and Nos. 2 and 8 Parties (North-Western Provinces and Oudh) at Sháhjahánpur, returning to Calcutta on the 5th February. On the 18th he went to Goalundo to confer with the Director of Land Records and the Superintendent, Provincial Surveys, Assam, on matters connected with the survey operations in that Province, returning the next day, and on the 22nd he accompanied the Surveyor-General to Burma and inspected No. 7 Party at Mandalay and No. 3 Party at Toungoo and Prome. He returned to Calcutta on the 28th March, and proceeded on furlough out of India on the afternoon of the 30th idem, handing over charge to Major Longe, who accompanied the Surveyor-General to Jubbulpore on the 11th April to discuss with the officer in charge the future composition and work of the Central Province Detachment and inspected the office there. He returned to Calcutta on the 14th idem, and on the 29th he left for Azamgarh and there conferred with the Superintendents Provincial Surveys, North-Western Provinces and Oudh and Bengal, on the general arrangements as to superintendence and division of work between the administrative and executive officers in the two Provinces, with a view to modifying and reducing the heavy strain thrown on the shoulders of the Superintendent, Bengal Surveys, by the existing system. After visiting the office there he proceeded with the Superintendent, Provincial Surveys, North-Western Provinces and Oudh, to Mankapur, Balrámpur and Fatehgarh, visiting the various survey offices at those places. He returned to Calcutta on the 9th May and left for Assam on the 14th idem, inspected the office of No. 14 Party and the Assam Drawing Office at Shillong and the Assam Detachment at Tezpur. On the 3rd June he returned to Calcutta and left again on the 10th to arrange with the Surveyor-General the future programme of the survey parties under his charge and especially that of No. 18 Party, to which was to be added the Punjab Detachment, and that of No. 14 Party whose work in the Lushai hills it was decided to stop. Various circumstances detained him there till the 10th August, when he again returned to Calcutta. On the 23rd idem he left for Bangalore to inspect the recess offices of No. 3 and Nos. 9 and 19 parties, and to discuss with the Surveyor-General the future of the various survey parties then working in Burma. He returned to Calcutta on 16th September and left again on the 19th for Naini Tal to inspect the office of Nos. 2 and 8 Parties and the North-Western Provinces Drawing Office. Subsequently he proceeded to Mussooree and completed the final arrangements for the reorganisation of No. 14 Party, and for the amalgamation of No. 18 Party and the Punjab Detachment, and inspected the office No. 4 of Party at that place.

5. Major Burrard visited Mussooree in June 1901 and inspected No. 24 Party, and in July inspected Nos. 22 and 23 Parties. In August he inspected No. 18 Party at Simla. In September he inspected No. 26 (Magnetic) Party at Mussooree, and No. 25 Party (Tidal and Levelling) at Dehra Dún, and in October No. 12 Party (Sind) at Karáchi.

6. Major Gordon inspected the various detachments of the Forest Surveys in the field in the Central Provinces, Bengal, Jubbal and Tarhoch, and Hazára, and No. 20 Party in the field in Burma and also during recess at Dehra Dún.

FIELD PARTIES.

7. Field operations were carried on by one double and sixteen ordinary parties and three detachments; of these one was employed on trigonometrical, eight on topographical surveys, one double and one ordinary party on Forest surveys, two on cadastral surveys, three detachments on traverse surveys and four parties on scientific operations; the difference from the previous year being that a scientific party has been added to the list, and that the detachment employed on traverse operations in Bengal is not classed as a detachment, being reported upon under the head of cadastral surveys.

8. The operations of the Forest Survey Branch, which are under the administration of the Superintendent, Forest Surveys, are fully reported on in the Forest Survey Report, and are therefore only briefly mentioned here.

The surveys carried on by local agency in the North-Western Provinces and Oudh, which are under the general supervision of the Deputy Surveyor-General, have also been included in this report under the head of cadastral surveys.

9. In the following statement the whole of the operations are grouped according to the nature of the work on which the parties are employed.

Statement of Survey Operations and Parties.

No. of Party.	Nature and *locale* of operations.	Page in this Report.	Executive Officers.	Scale of Survey.	Administrative Superintendent.
				Inch Mile	
	Trigonometrical.				
24	India Triangulation	21	Captain H. H. Turner, R.E. Lieutenant H. Wood, R.E.	.....	Supdt., Trig.
	Topographical.				
3	Lower Burma	22	Mr. E. Litchfield	2=1 1=1	D. S. G., Rev.
10	Upper Burma	24	Captain F. W. Pirrie, I.S.C.	1=1	D. S. G., Topo.
11	Ditto	25	Mr. P. J. W. Doran	1=1	Ditto.
21	Ditto	26	Mr. C. F. Hamer „ A. J. James Lieutenant E. T. Rich, R.E. „ E. A. Tandy, R.E.	16=1 1=1	Ditto.
12	Sind	27	Mr. C. F. Erskine	2=1	Supdt., Trig.
14	Lushai Hills	28	Captain C. L. Robertson, R.E. Lieutenant C. P. Gunter, R.E.	1=1	D. S. G., Rev.
15	North-Western Frontier.	29	Colonel R. A. Wahab, R.E. Captain G. A. Beazeley, R.E. Mr. E. A. Wainright	2=1 1=1 ½=1	D. S. G., Topo.
18	Himalayas, Punjab	30	Major W. J. Bythell, R.E.	4=1 2=1 1=1	Supdt., Trig.
	Forest.				
9 & 19	Madras Presidency	32	Mr. H. Todd	4=1	D. S. G., Rev.
17	Bombay Presidency	33	Mr. S. F. Norman	16=1 8=1 4=1	D. S. G., Topo.
	Bengal				
20	Burma	35	Forest Survey Branch	4=1	Supt., Forest Surveys.
	Central Provinces.				
	Punjab				

Statement of Survey Operations and Parties—contd.

No. of Party.	Nature and *locale* of operations.	Page in this Report.	Executive Officers.	Scale of Survey.	Administrative Superintendent.
	Cadastral.			Inch. Mile.	
2 & 8	North-Western Provinces and Oudh.	37	Mr. G. B. Scott Captain W. M. Coldstream, R.E.	16=1	D. S. G., Rev.
4	Bengal	39	Major G. B. Hodgson, I.S.C. Captain A. Mears, I.S.C. [illegible]	16=1	Ditto.
7	Burma	46	Mr. E. G. Little „ J. Connor	16=1	Ditto.
	Traverse.				
	Assam	48	Mr. T. Shaw	.....	Ditto.
	Central Provinces	50	Mr. W. C. Price „ M. Gastaud „ R. C. D. Ewing	.....	Ditto.
	Punjab	52	Mr. R. B. Smart	.....	Ditto.
	Geodetic.				
22	India	55	Lieutenant H. M. Cowie, R.E.	.....	Supdt., Trig.
23	Ditto	56	Captain G. P. Lenox-Conyngham, R.E.	.....	Ditto.
	Tidal and Levelling.				
25	India	57	Captain H. L. Crosthwait, R.E. Mr. E. J. Connor	.....	Ditto.
	Magnetic.				
26	India	59	Captain H. A. D. Fraser, R.E.	.....	Ditto.

OUTTURN.

10. The total outturn of detail survey for the year amounts to 48,106 square miles, of which 17,000 are reconnaissance survey on the ½-inch and smaller scales, and 31,106 square miles are rigorous surveys on various scales. To the total area may be added 17,000 square miles of reconnaissance survey on the ½-inch scale surveyed by the officers and men of this and of the Intelligence Department attached to the China Field Force. A comparison with last year's outturn shows an increase of 1,688 square miles of rigorous survey, but a great decrease of reconnaissance work, mainly owing to there being no exploring parties at work on the North-East Frontier.

The total area triangulated, excluding 16,000 square miles by the survey detachment with the China Field Force, is 44,379 square miles.

The total area traversed for Cadastral Surveys is 6,997 square miles situated as follows—2,615 square miles in the North-Western Provinces, 3,611 in Bengal and 775 in Burma. This item is 1,147 square miles in excess of last year's outturn.

TRIGONOMETRICAL SURVEYS.

11. The Triangulation Party (No. 24) this year again worked in two sections, one of which carried on the minor meridional series, which had been commenced last year, and effected a satisfactory junction with the Mandalay Minor Longitudinal Series. The other section of the party commenced a new principal series which will run eastwards from the neighbourhood of Katha to the Salween, and then turn southwards along that river. Satisfactory progress was made by both sections.

TOPOGRAPHICAL SURVEYS.

12. The number of parties engaged on topographical surveys is the same as that of the previous year and the *locale* of their operations has been the same. Four of these, *viz.*, Nos. 3, 10, 11 and 21 continued to work in Burma, the three latter in Upper Burma and No. 3 in Lower Burma.

13. The work of No. 3 Party consists for the most part of surveying such portions of Lower Burma as have been untouched by the Cadastral Surveys. These latter have only taken up the survey of cultivated areas, so that many blanks remain on the standard sheets which must be filled up to render the sheets available as topographical maps.

The sheets taken up were for the most part in the Sandoway, Thayetmyo, Pegu and Toungoo districts. The outturn for the season was 1,130 square miles topographically surveyed on the 1-inch and 202 square miles on the 2-inch scale, and 600 square miles of triangulation in advance. The outturn is a comparatively poor one owing partly to the difficulties of the country but mainly to the extreme unhealthiness of the season. The country to be surveyed in the coming season is more promising, but it is a question for consideration how far such surveys are worth the cost. This point is being closely looked into.

14. The work of No. 10 Party is confined to the west of Longitude 96°30′ and consisted of 1-inch survey of parts of the Ruby Mines, Shwebo and Yamèthin districts, and of additions to and revision of the topographical maps compiled from the Cadastral surveys, such maps being quite useless for general purposes without such revision. The outturn of the season is 4,068 square miles of triangulation, 1,285 of original topographical survey and 2,023 square miles of revisionary survey. The cost-rates of the two latter are R26 and R22 per square mile respectively, showing that a complete resurvey would be only slightly more costly than revisionary work.

15. Nos. 11 and 21 Parties continued to survey the Shan States, the portions under survey being the country north and east of Lashio and that south-east of Lashio on the western side of the Salween river.

The aggregate area surveyed by the two parties was 6,686 square miles of triangulation and 4,265 square miles of topography on the 1-inch scale, an area considerably in excess of that of last year. Although a good deal of the country surveyed is rough and jungle clad, it supports a large population and considerable areas are under cultivation.

As the greater portion of the valuable and well-populated parts of the Shan States has now been surveyed, these two parties will be amalgamated and employed in completing such portions of the country on the 1-inch scale as may seem advisable, and in filling up and improving the ¼-inch maps of the outlying portions of Burma.

The result of the season's work in Burma is an addition to our topography of 8,905 square miles.

16. The survey of Sind on the 2-inch scale was continued by No. 12 Party in the northern part of the Province. An area of 2,553 square miles was topographically surveyed at a cost of R12 per square mile. In addition a large area was triangulated and traversed in advance.

17. No. 14 Party was again employed in surveying the Lushai Hills. Eight hundred and seventy square miles of detail survey were completed and 1,122 square miles of triangulation carried out. As the more important portion of the Lushai country has now been surveyed this party will be transferred to the North-Western Provinces for topographical purposes.

18. No. 15 Party as heretofore has been employed on various surveys for the Military Department chiefly in Sind, the Punjab and Kashmir. In Kashmir and adjacent countries although the work was very considerably interrupted by an abnormally stormy season, an area of 3,224 square miles was surveyed on the ½-inch scale, and a carefully executed series of triangles covering an area of 5,000 square miles was carried in from the Kaghan valley as far as Gilghit. In Sind an area of 1,915 square miles was surveyed on the 1-inch scale.

To this party has been allotted the execution of the surveys of the various Military Cantonments which are required under the new Cantonment Act.

19. No. 18 Party, which has been for a considerable time surveying in the Kángra and Simla districts, has practically completed its original programme

during the year; 488 square miles were surveyed on the 1-inch, 951 on the 2-inch and 109 on the 4-inch scale. The Estate boundary survey of the Simla Municipality is being pushed on, and should be completed next season.

This party will in future be employed in the plains of the Punjab in compiling, testing and completing topographical maps from materials supplied by the Settlement maps. They will also undertake such special work, as Riverain Surveys, as may be required by the Punjab Government.

20. The total outturn for the year under the head of topographical surveys on various scales from 1-inch upwards amounted to 16,913 square miles against 14,547 square miles completed the previous year. The total is made up as follows :—

12,416	square	miles	surveyed	on	the	.	.	. 1-inch scale.
4,388	"	"	"			.	.	. 2 " "
109	"	"	"			.	.	. 4 " "

FOREST SURVEYS.

21. The special surveys of Government Forests were, as in previous years, carried out by the Forest Surveys, Bengal Presidency, and by Topographical parties of the Survey Department. The general procedure differs widely.

22. In Bombay No. 17 Party, which is under the general professional superintendence of the Surveyor-General, is as regards its programme and the cost of operations entirely under the control of the Local Government. The Government of India has hitherto contributed a sum of ₹10,000 annually, in consideration of the topographical value of the survey of North Kánara, of which no reliable survey existed; as the survey of this district was completed during the year under report, this contribution will now cease.

23. In Madras the double Party, Nos. 9 and 19, is under the control of the Surveyor-General. In this Province one-third of the cost of the survey is paid out of Imperial funds.

24. In the Punjab No. 18 Party, under the administration of the Superintendent, Trigonometrical Surveys, in addition to its regular topographical work, carries out the survey of forest lands in several districts.

25. The rest of the Forest Surveys in India are under the administrative charge of the Surperintendent, Forest Surveys, Bengal Presidency, under the orders of the Inspector-General of Forests and the administrative charge of the Surveyor-General. Revised orders for the adjustment of expenditure on these forest surveys have been issued by the Government of India, by which it is provided that the cost of all Forest Surveys, on a scale of not less than 4 inches to a mile, in the North-Western Provinces and Oudh, the Punjab, Central Provinces, and Burma, shall in future be uniformly distributed in the proportion of 30 per cent. to topographical surveys, in consideration of the topographical value of the work, and of 70 per cent. to Forests. The cost of surveys executed by Local Forest officers and of special surveys on a particularly large scale will, as heretofore, be borne by the Forest Department. The programme is arranged by the Surveyor-General and the Inspector-General of Forests.

26. In Bombay as in previous years the forests have been surveyed on three different scales according to their nature. Surveys were carried on in all three forest circles, the outturn on the various scales being as follows. On the 4-inch scale 410 square miles, on the 8-inch 255 square miles and on the 16-inch 11 square miles. The cost-rates were respectively ₹65, ₹107 and ₹113, comparing favourably with those of previous years. This party has suffered very severely from plague, a number of the best surveyors having died during the last few years, a loss which it is difficult to replace.

27. In Madras the double party, Nos. 9 and 19, continued work as before, surveys being carried on in the Kurnool, Cuddápah, South Canara and Coimbatore districts. The party suffered considerably in health but succeeded in mapping 1,378 square miles of forests at a cost-rate of ₹58 per square mile of detail survey.

28. In Burma No. 20 Party surveyed 873 square miles on the 4-inch and 5 square miles on the 2-inch scale, in Ataran, Rangoon, Pegu, Thayetmyo, Yamèthin and the Ruby Mines districts. The cost-rates of detail survey were practically the same as for last year, *viz.*—₹97 per square mile. The rates for

traversing were considerably less and those for triangulation somewhat in excess of those of the previous season, the increase being solely due to loss of time caused by a necessary change in the programme during the field season.

29. In the Central Provinces 1,556 square miles of forest lands were surveyed by five detachments of the Forest Survey Branch, on the 4-inch scale at a cost-rate of R36, in Mandla, Damoh, and Chánda districts. The cost-rates of all classes of work, which may now be considered to have reached their minimum, are somewhat more favourable than for last year.

30. In Bengal the survey of the Singhbhum Reserved Forests on the 4-inch scale was continued by two detachments of the Forest Survey Branch. Three hundred and sixty-one square miles were surveyed at a cost-rate of R61 per square mile, about 25 per cent. less than for 1899-1900.

31. In the Punjab the survey of the Jubbal and Tarhoch State Forests was commenced, and 43 square miles were surveyed on the 4-inch scale.

In the Kángra and Hoshiárpur districts 50 square miles of forest were surveyed on the 4-inch scale and in the highlands of Kullu an area of 376 square miles of forest lands was mapped on the 1-inch scale.

32. The total outturn of Forest Surveys executed on various scales during the year amounts to 4,892 square miles, of which 2,838 square miles were surveyed by the Forest Survey Branch. The figures are as follows:—

	Square miles.
2-inch scale	5
4 „ „	4,621
8 „ „	255
16 „ „	11

CADASTRAL SURVEYS.

33. As in the preceding year, there was, during the year under report, one cadastral party in Burma under the direct administration of the Deputy Surveyor-General, while one was employed in Bengal and one in the North-West Provinces under his general professional superintendence, the programmes and cost of the operations being entirely under control of the Local Governments.

34. The main portion of the work of the Burma party lay in the Lower Chindwin district in Upper Burma. An area of 666 square miles was traversed and a cadastral survey of 808 square miles executed on the 16-inch scale. In Lower Burma the work consisted of the traverse of a number of isolated areas situated in dense jungle in the Sandoway district. An area of 105 square miles was completed.

35. In the North-West Provinces the establishment has been divided into three sections, traverse, cadastral, and drawing. The traverse section completed the traverse survey of districts Azamgarh, Farrukhabad, Mainpuri, Etáwah and Jálaun, and the scattered areas in Aligarh where cadastral survey is required. With the exception of a small area remaining in Etah this completes the programme of traverse survey at present required by the Local Government, and the bulk of the traverse party will now revert to Imperial work. The total area traversed was 2,575 square miles. The cadastral section completed the survey and *khasra*-writing in Gonda, Farrukhabad and the areas of Aligarh where such surveys were required. Operations were also carried on in Azamgarh, Mainpuri, Etah and Jálaun. The total area cadastrally surveyed was 3,944 square miles. During the year large scale surveys have been made of the towns of Cawnpore, Fyzabad, Ajodhya and Mainpuri. The scale adopted was that of 64 inches to the mile.

The drawing section is located at Naini Tal. Its cost is an Imperial charge and its employment is to construct topographical maps out of the material furnished by the cadastral surveys. The maps of two districts, Sháhjahánpur and Bareilly have been completed and those of Bahraich, Pilibhít and Kheri are in progress. It is somewhat doubtful whether these maps can be accepted as they are compiled or whether they will have to have their topographical detail revised and added to in the field before they are published. A close comparison which is about to be made between the maps of the Meerut district compiled from the cadastral surveys and those executed by the previous topographical survey of that district will throw light on this point.

36. In Bengal a considerable extension of cadastral surveys took place during the year. An area of 1,244 square miles was cadastrally surveyed on the 16 inch scale and the records written of 1,416 square miles in districts Monghyr, Patna, Darbhanga and Backergunge. The amount of traversing shows a very large increase on previous years, an area of no less than 3,695 square miles lying in districts Monghyr, Patna, Darbhanga, Purnea, Gaya, Backergunge, Singhbhum and Champáran. The sudden expansion of traverse work has heavily taxed the resources of the department.

The title of the Superintendent has been changed to that of Superintendent, Provincial Surveys, Bengal.

37. The total areas cadastrally surveyed during the season in the several provinces are as follows:—

	Square miles.
Burma	808
North-Western Provinces	3,944
Bengal	1,244

TRAVERSE SURVEYS.

38. In Assam the traverse detachment under the Superintendent, Provincial Surveys, traversed an area of 237 square miles, mainly of extension surveys of villages and of tea grants. A certain amount of boundary demarcation and survey was also carried on.

39. The Central Provinces Detachment was employed on traversing village boundaries and excised portions of Forest Reserves. The work was scattered through a number of districts, and an area of 845 square miles was traversed. The drawing section was occupied in compiling topographical maps from the cadastral sheets; the checking and correcting these sheets in the field is a work which will have to be carried out by this detachment.

40. The original programme of the Punjab Detachment was to run traverses over the Hazára district, but it was diverted to the Montgomery district and took up the work of traversing there, fixing the trijunctions of villages. In addition the commencement of a system of Riverain Traverse Surveys was made. These are being done with a view to determine the exact position of the Riverain boundaries which are now being fixed once for all throughout the Punjab. The total area traversed by the detachment was 2,670 square miles.

41. The total areas traversed during the year excluding those traversed by cadastral parties for their own surveys are as follows:—

	Square miles.
Assam	237
Central Provinces	845
Punjab	2,670

SPECIAL OPERATIONS.

42. No. 22 Party was employed during the year in determining astronomical latitudes on the Karáchi Longitudinal Series between the meridians of 67° E. and 72° E. Longitude. Observations were taken at eleven stations, the instrument used being Troughton and Simms' Zenith Telescope No. 1.

43. No. 23 Party was employed during the season on experimental work connected with the Jäderin Base line apparatus.

The experimental re-measurement of the Dehra Dún Base Line which took place last year showed the necessity of a very careful determination of the coefficients of expansion of the wires employed in the measurement. Apparatus was devised for the purpose and a very satisfactory determination was arrived at.

44. Tidal operations were carried on by No. 25 Party at thirteen stations throughout the year, seven of them being permanent. The observatory at Bushire was closed during the year, the observations there having been completed.

The Levelling operations were continued along the Eastern Bengal State Railway, the line crossing the Ganges river at Dámukdia Ghát and closing at Siliguri. Three different methods of carrying the levels across the Ganges were

employed as the river was far too wide to cross by the ordinary method of levelling. The agreement of the three methods was satisfactory. The outturn amounted to 211 miles of double levelling.

45. The Magnetic party which was formed in December 1900 was employed for the rest of the year in making preparations for the work. Base stations at which continuous magnetic records will be made are required at Bombay, Calcutta, Kodaikánal, Dehra Dún and Rangoon. At Bombay and Calcutta such observatories already exist, but unfortunately the introduction of Electric tramways in these two cities will vitiate their magnetic records and it has become necessary to arrange for other observatories which will be free from the effects of the electric current. It is hoped that these arrangements will be made in sufficient time to allow the field observations to be continued without break.

GEOGRAPHICAL SURVEYS AND RECONNAISSANCES.

46. Under this head are included surveys and reconnaissances which are executed on the $\frac{1}{2}$-inch or smaller scales. In Kashmir and neighbourhood an area of 3,224 square miles was surveyed on the $\frac{1}{2}$-inch scale, and on the N.-W. Frontier an area of approximately 20,000 square miles was mapped on the $\frac{1}{4}$-inch and $\frac{1}{8}$-inch scales.

A survey party, consisting of Major Renny Tailyour, R.E. (in charge), Munshi Ikbaluddin, K. S., and three surveyors, was sent with the China Field Force. Captain C. H. D. Ryder, R.E., being in China at the time was ordered to join the Field Force where he remained until the whole party returned in August 1901. Thanks to the energy of Major Renny-Tailyour and Captain Ryder, and the co-operation of the Intelligence Branch, the triangulation of 16,000 square miles of country was completed, and the large area of 17,000 square miles was mapped in detail on the $\frac{1}{2}$-inch scale. Major Renny-Tailyour has since been promoted to Brevet Lieutenant-Colonel.

HEAD QUARTERS OFFICES, CALCUTTA.

47. The general direction of these offices remained in the hands of Colonel St. G. C. Gore, R.E., Surveyor-General of India, throughout the year. The Revenue Branch Section was under Colonel J. R. Hobday, I. S. C., Deputy Surveyor-General, up to 30th March 1901, when he proceeded on leave and Major F. B. Longe, R.E., was appointed to officiate for him.

48. The other offices in Calcutta were, as usual, supervised by three Assistant Surveyor-Generals. The General and Topographical Branch Sections as well as the Mathematical Instrument Office were under Major Longe, R.E., up to 30th March, and thereafter under Major G. B. Hodgson, I.S.C. The Drawing, Engraving and Map Record and Issue offices were under the supervision of Major J. M. Fleming, I. S. C., throughout the year, while the Photo-Litho. Office was under Mr. T. A. Pope, up to 15th November 1900, when he proceeded on furlough and Mr. A. E. Spring succeeded him. Major Hodgson was on duty at Head-Quarters from 26th November 1900 to 30th March 1901.

49. In the *Correspondence Office* there has practically been no change in the procedure.

50. *Drawing Office.*—The Geographical Section has been engaged on the compilation of the various general maps, as well as the bringing up to date and adding to sheets when fresh material is available, and preparing for press and publishing these, as well as sheets received from the various field parties. Of the North-East and South-East Frontier Series seven sheets have been completed and published, while ten more are passing through press or in hand. Eight more sheets have been added to or brought up to date. Many of these sheets are in several sections, additions having been made from time to time, or more reliable work substituted for that already drawn. As this causes frequent mistakes, an attempt is now being made to join up all the latest material in single sheets. Several have been thus treated and the result should be a considerable saving in time in reproducing them when required. Of the North-western Frontier Series two sheets on the 1-inch and $\frac{1}{2}$-inch scales have been brought up to date.

Of the 1-inch standard sheets, five of the Burma maps have been under preparation, and of these three are either at, or almost ready for, press. Thirteen other sheets have been prepared for press and published, while additions to five more have been made. Of the standard sheets of the rest of India 45 have been in hand, and of these 25 have been published, the remainder being under publication or awaiting further material. Of the Madras Forest Survey on the 4-inch scale, 47 sheets have been dealt with, and of these 35 have been completed and published. Nineteen Provincial maps on various scales have been brought up to date. Of District maps on the $\frac{1}{4}$-inch scale, 25 have been added to in various ways. These maps, particularly in Assam and Bengal, are mostly compiled from old Atlas sheets, and often in a very unsatisfactory state. Several complaints have lately been received about them; one stated that a river shown on the map was 15 miles out of its true position, another that on one of these maps, along a road inserted from extra-departmental sources, the adjoining villages fell on the wrong sides of the road, while a third stated that owing to changes all over, the sheet supplied was utterly useless. Twenty-two of the Administration report maps on different scales have been in hand, and of these seven have been completed and published. Of the sheets of the Atlas of India 116 have had additions made to topographical features or names, while eight have had hills brush-shaded for the Engravers, and a considerable amount of brush-shading on other maps has also been done. The various Departmental General maps of India on various scales have all been in hand for revision, and most are now quite up to date, and will shortly be ready for issue, revised in railways and boundaries. Progress on the new 64-mile map has been suspended for the present owing to press of work, but a considerable amount of outline in one sheet has been engraved. It is now proposed to prepare this sheet by reduction from a new 32-mile map of India. The compilation of the duplicate 64-mile map of India has made satisfactory progress, while that of the new material for the outline of the new 32-mile Litho. map of India is practically finished. A new edition of the 48-mile railway map has been issued, but as the stones are very much worn out and the map somewhat out of date, a new edition is under preparation, and is well advanced. The 32-mile map of India showing railways with stations has at last been published, while that on the same scale showing railways and canals has been brought up to date in railways and boundaries, and will, it is hoped, shortly issue. It is intended to bring out a new engraved map of India on the 32-mile scale, and a good deal of revision of the existing map on the same scale as well as of fresh compilation has been accomplished. Of the new $\frac{1}{1,000,000}$ scale map of India and adjacent countries two sheets (Nos. 78 and 83) are approaching completion in outline, and another has been projected. It is now intended to engrave at once such sheets of this map as reliable material is available for, instead of bringing out a preliminary photo-zinco edition as was originally intended.

The maps of various cities and cantonments have been brought up to date or added to, and new maps of Maymyo on the 16-inch scale in 15 sheets and of Aijal in two sheets on the 24-inch scale have been sent to press, and the first published.

As usual there has been a very large amount of extra-departmental work.

A series of 23 maps of the various Provinces or Districts of India was prepared under instructions received from the Census Commissioner. Some of these had to be subsequently added to or modified at the request of the local officials, and two additional maps to supersede the one first supplied have been prepared for the Central Provinces. The Route map of the Punjab and Bengal Command has been most troublesome from various causes; but it is hoped that the latest proof submitted to the Military Authorities will be finally approved. Eight sample sheets (comprising Bihar and part of Bengal) of a proposed new postal Atlas of India on the 8-mile scale have been in hand, and proofs have been supplied to the postal authorities for approval. Other maps have been prepared for the Archæological and Botanical Surveys, and for the Foreign, Military, Forest, and Medical Departments.

The Section has been until the latter part of the year much handicapped by lack of supervising Establishment and at times work has been carried on under great difficulties. Owing to this, the much needed revision of the map catalogues has had to be delayed, though that of Madras is now ready for press.

Now that a sufficient staff is available, this work will be resumed and it is hoped completed before long. The Catalogues of Bengal, North-Western Provinces and Punjab are already well advanced.

51. In the Examining Section, which has been particularly handicapped from want of efficient supervision, 2,358 sheets of sorts have been dealt with, showing once more an increase of work done.

52. In the Revenue Section of the Drawing Office the maps of Calcutta on the 6-inch and 3-inch scales have been published. Neither being very satisfactory a commencement has been made of an engraved map on the larger scale, and a considerable amount of outline has already been made over to the Engravers.

Maps of Allahabad, Bareilly, Bhágalpur, Cawnpore, Rangoon and Quetta have been in hand either for preparation or revision for republication.

The Peshâwar District Standard sheets, prepared from old Revenue maps, supplemented by revision work from the *Patwaris* Survey, have been published without the external boundaries, which, as taken from the professional Topographical Surveys, it has been found impossible to reconcile with the features on these sheets. An attempt will be made to enter these after a resurvey which is contemplated, and when completed a new edition will be brought out. One hundred and forty-seven standard sheets (37 being first editions) of the Punjab, North-Western Provinces, Assam, Bengal, Bombay, Central India, and Burma have been dealt with, and are either at press or republished. Several of the Burma sheets have been completed to margin from material supplied by the Director of Land Records. Thirty-seven of the Bengal and North-Western Provinces sheets which are out of print, have again, as no originals fit for reproduction are available, been prepared for press by touching up old litho. prints with white lead. These will have to serve as originals until something better can be provided; this procedure involves much labour, and the results are hardly fit for civilized use, and bring undeserved discredit on the Department, which is forced to issue them if the Public is to have any maps at all of these districts.

Several new index maps have been prepared and the existing ones revised and brought up to date. Two thousand and forty-seven pages of extracts from traverse data have been copied, checked, and supplied as required to Departmental or other Government Officials. A final examination has been made of the traverse records of Muzaffarpur and Shwebo and these have been now lodged in the Map Record and Issue Office.

Sixty traces, and copies of 336 original village plans have been supplied to district officials, while 900 applications from private parties for copies of original records have been received and disposed of during the year. On these applications 2,500 copies of map or traverse data were supplied, the Government fees realized amounting to ₹1,388.

Thirteen thousand, nine hundred and twenty-three maps for issue to the Public have been coloured and examined, and in addition 2,317 pairs of office copies have been either newly prepared or brought up to date and compared, making a total of 2,782 in all which have been thus scrutinized. The renumbering of all the existing Burma sheets rendered necessary by the recent change of number of the standard sheets has been taken up in this Section, and 8,986 printed sheets have been dealt with. Almost all the 1-inch standard sheets have been completed, but the majority of the 4-inch still remain to be done. This task has been a very laborious one; the new sheet numbers have been pasted over the existing ones, the numbers of adjoining sheets in the index table being altered by hand. Index maps giving the new numbers have been distributed as widely as possible, but still a considerable amount of misunderstanding and confusion results from the change, both in the office and amongst the outside public, and is inevitable for some time to come.

53. In the Cadastral Section the 252 sheets of the Tikâri Wards Estates remaining over from last year, with 34 sheets since received have been published. Of the Burma Survey 2,960 sheets remained over from last year, and during the year 6,531 sheets of districts Shwebo, Katha, Minbu, Yamèthin, Myingyan and Upper Chindwin in Upper Burma, and 1,343 sheets of districts Toungoo, Lower Burma, were received from the field party. Of this large total of 10,834 sheets, 4,897 have been published during the year, leaving a balance of 5,937 sheets in hand. Complaints have been received from the civil authorities regarding the slow rate at which these cadastral sheets are being delivered, but as at present

worked the outturn depends mainly on the number of zinc plates which can be prepared for the press. The printing has now been quickened and can deal with the maximum number of plates which can be got ready daily for the press. The only method of increasing the outturn is to utilize Vandyke's process for preparing the plates. Unfortunately the original cadastral sheets are unsuited for direct reproduction by this process as they are rendered opaque in many places by white paint obliterations and by notes pasted on them. It is hoped that arrangements can be made by which this office will be supplied with traces of the sheets which can be directly printed by Vandyke's process on to the zinc plates. If this is done a small temporary increase to the zinc printing establishment will enable the outturn to be almost doubled. Enquiries are also being made as to the possibility of so preparing the original cadastral sheets in future as to render them capable of being reproduced directly on to the zinc. The total number of maps passed for press in the Section was 5,207, of which, as above stated, 5,183 have been actually printed, 1,228 of these having been zincographed from transfer traces prepared in the Section. In addition a good deal of miscellaneous work has been done for Collectors, Settlement Officers, etc., while *Badar* corrections have been made in the field area statement of the Chakla Roshnabad Estate.

Twenty-five sheets of various districts have also been reprinted at the request of the Civil authorities to replace others lost or damaged.

Thirty-eight sheets of the Calcutta City Survey have been revised. Of these 12 have been examined and sent to press, and the remainder will be shortly taken in hand.

54. The outturn of work in the *Engraving Office* is practically the same as last year. Three new Quarter Atlas sheets have been completed and published, while new material has been added to 74 Quarter sheets which are in various stages of progress. One hundred and fifty-eight published quarter plates and 57 old full plates have had additions or corrections made to them, while 44 new quarter sheets have been projected or had borders cut.

The new 32-mile map of India which it is intended to bring out in 12 sheets has progressed. Sheet 9, containing however little detail, has been reprojected and is completed, while matrices of sheets 7 and 10 have been received, and are being corrected before duplicates are prepared. Sheet 8 is being reprojected in order to have new material engraved, as will also be done with sheets 1 and 12. The old 64-mile map with hills has been brought up to date as far as possible and published, and sheets 1 and 2 of the duplicate map have had entirely new material on the east and west frontiers engraved on them in outline, and a good deal of the lettering completed as well, and have also been brought up to date in railways and spelling of names.

A large piece of new outline has been cut on sheet 3 of the new map on the same scale, but it has been decided not to proceed further with this map at present. The maps of India on the scales of 1 inch=80, 128 (with hills and outline) and 256 miles are all in hand being altered largely to bring them up to date, and are approaching completion. A matrix of the route map of the Western Himalayas has been corrected and the engraving of the large amount of new material will be shortly commenced. The 16-mile Provincial map of Madras in 6 sheets has been practically finished in outline, but it has been decided to improve it by adding the entire detail in the Mysore State, and this will delay the publication for a little. The four sheets of the Punjab map on the same scale have all been in hand, particularly heavy additions as well as corrections having been made to sheets 1 and 3. These should be completed before long and the result will be a much enlarged and improved map. The maps of the Central Provinces, Central India Agency, Rájputána, Mysore and Gujarát on the 16-mile scale have all been attended to, while the map of the Punjab on the 32-mile scale has been in hand for names, and that of the Berars on the 8-mile scale has been brought up to date. Two new provincial and three new district maps for administration reports have been completed, while three and 27 respectively have been added to, and a similar map of Darjeeling has had the hills completed.

Considerable progess has been made with the outline of a new 6-inch map of Calcutta, while much other miscellaneous work has been done. Altogether 477 plates have been dealt with.

Twenty-three plates have had corrections filled in by electro-deposition which continues to give satistactory results. The copper-plate printing section pulled 25,917 impressions, the increase on last year's outturn being mainly due to the number of scales, etc., printed, and transfers of 30 Atlas sheets were pulled and sent to the Photo.-Litho. Office where the required copies were printed from stone. Until such time as additional space and presses are available, this is the only way in which the public demand for these Atlas sheets can be met, and the results are of course far inferior to those obtained direct from the copper-plate. Over 100 Atlas sheets are still out of print and a further supply must be obtained in this way to assist the copper-plate presses.

Two hundred and seventy plates have been steel-faced during the year.

55. In the *Photographic and Lithographic Office* the outturn of work during the year has been the largest on record. The number of departmental maps received for publication, excluding cadastral maps, amounted to 1,197 or 214 more than last year, while the total number of copies printed was 192,466, or 93,290 in excess of last year. The actual amount of map printing done for the Survey Department was thus nearly double that done last year. This satisfactory outturn is to be attributed in a great measure to the small increase made during the year to the number of zinc-correctors and compositors and to the three new zinc presses received, which have enabled the zinc-printing section to complete a large quantity of outstanding work, chiefly standard sheets. The arrears mentioned in paragraph 60 of last year's report no longer exist, and now that the establishment in this section is up to its proper strength they will not be allowed to accumulate again. As regards work done for other departments and officials there is also a very considerable increase, in spite of the fact that fewer demands have been made on the office for maps and diagrams to illustrate annual reports. The total number of extra-departmental subjects received was 2,112, or 578 more than last year, while the number of copies printed was 708,355, or an excess of 119,762 over last year. There was an enormous increase in the number of cadastral maps dealt with, which was rendered possible by the introduction of the new method of direct zincography, without negatives or transfers, described in last year's report. This process enabled the office to undertake the reproduction of a large number of Bengal Cadastral maps, and these have been disposed of at the rate of about 30 daily. But as the Cadastral printing staff was insufficient to deal with the printing of these, this work has been done, by special arrangement with the Bengal Government, as overtime. This arrangement is to cease in April 1902, when the Bengal Drawing Office will undertake the reproduction of their own Cadastral work, and consequently it is not to be expected that the very large outturn of this work shown by the Photo.-Litho. Office for the past year will occur again. The total number of cadastral maps received during the year was 13,142, or 8,200 more than last year. Of these 8,125 were Bengal maps reproduced by the new process, and printed as overtime work: the remainder were sheets of the Burma Cadastral Survey, and were photo-zincographed, or zincographed from tracings, in the usual manner. The total number of copies of complete villages printed was 252,995 as against 162,733 printed last year. Of these 85,590 were copies of Bengal sheets, of which, as a rule, only ten copies are printed.

The aggregate number of copies printed in the machines and presses, comprising both departmental and extra-departmental work, amounted to considerably over a million, the exact figures being 1,153,816 as against 850,502 last year. Even omitting the 85,590 copies of Bengal Cadastral maps printed out of office hours, this total represents an outturn considerably larger than any previously recorded.

56. In the Type-printing section the amount of work done also shows a large increase, though fewer separate pages or items, were set up. The total number of copies printed was 984,189, or 172,062 more than last year. This section moved into the new building erected for its accommodation in January 1901 and is now working under much more satisfactory conditions than formerly.

The Silver-printing Section also records an increase of work done. Of ordinary silver-prints, the demands for which vary a good deal, 2,119 were made, or 1,148 more than last year. Of cyanotype, or blue prints, which are supplied as

proofs to the Drawing Office before transferring work to zinc or stone, there were 2,866, or 474 more than last year.

57. The Heliogravure Section shows an all-round increase, especially in the number of photo-etched plates and prints made. The number of plates etched was 115, or nearly double the number turned out last year, while the number of prints made was 58,782, as against 56,570. These included the usual work for the Technical Art series, and for the Indian Museum, to illustrate the Zoology of R. I. M. S. *Investigator*, and also a large number of prints to illustrate various publications of the Geological Survey, and the Honourable Mr. Buckland's work on "Bengal under the Lieutenant-Governors."

58. The following maps may be mentioned as the most important on which the office was engaged during the year:—

The Railway and Canal map of India in six sheets, on the 32-mile scale, which is under preparation for the Government of India, Public Works Department, was practically completed, and proofs were supplied, which were approved and returned with press order in July 1901. The publication of this important map is, however, still deferred, as the Drawing Office have made numerous corrections to topographical details and boundaries. It is hoped that it will be published before the end of December 1901.

The old 32-mile map of India, with hills, which has been so constantly added to and corrected during the past 13 years that the stones are completely worn out, is to be superseded by a new and greatly improved map on the same scale, and this work has been in progress throughout the year. The hills are being drawn on stone in chalk, to be printed in brown, which will be a great improvement to the appearance and legibility of the map. At the close of the year only one of the six sheets, No. 2, was completed in all respects; the hills on sheet No. 5 were drawn, and the outline work on sheets Nos. 4 and 6 was in progress. The sheets are being put in hand as fast as material is supplied by the Drawing Office, but it is impossible at present to give any forecast of the probable date of publication.

The Railway map of India, on the 48-mile scale, with hills in grey, was again brought up to date and printed off. Of provincial maps, a map of Assam and a map of the North-Western Provinces and Oudh, each on the 32-mile scale, were printed, and a map of the Punjab and Kashmir, on the 16-mile scale, was taken in hand. Of plans of cities and cantonments may be mentioned a map of Maymyo, in two colours; and new editions of the various 3-inch maps of the City of Calcutta. Five hundred and thirty-two standard sheets of the Topographical and Revenue Surveys, on various scales, were dealt with during the year, either as reprints or new editions.

59. While on furlough during the year Mr. T. A. Pope, the Assistant Surveyor-General in charge, visited the Ordnance Survey Office at Southampton, and found that certain improvements had recently been introduced there in the methods of photo-zincographing large maps. These are not now put down on zinc by means of paper transfers, but are printed direct on the plates from reversed negatives, thereby preserving the sharpness of the original and greatly facilitating the proper registration of colour work. In order to introduce this method into the Calcutta Office a camera has been indented for, and is shortly expected, large enough to photograph a standard sheet in one negative. The difficulty hitherto experienced, whenever this method has been tried in the past, in obtaining proper contact between the zinc plate and the negative, is overcome by the use of a new form of pneumatic printing frame, which is also being procured. If no unforeseen difficulties arise, and none are likely to occur, this camera will completely revolutionise our present old-fashioned method of reproducing the larger publications of the department. All the coarseness due to the use of paper transfers will disappear, as will also the faulty registration which so frequently disfigures maps printed in colours, more especially in the case of standard sheets with hills printed in brown, due to the irregular expansion or shrinkage of the paper transfers at present employed. Some difficulty may be found in using the new method in the case of maps which have been drawn for reduction, in several sections, but these can probably be overcome; and the practice of drawing originals on an enlarged scale for reduction in the camera will, it is hoped, prove unnecessary in most cases, as the direct reproduction now aimed at should entirely preserve the sharpness of the original drawing.

The new camera has been built by Messrs. A. W. Penrose and Co. of London under Mr. Pope's personal supervision. It is fitted with a Zeiss lens of suitable powers, and a reversing prism working in front of the lens.

60. The process invented and patented by Sub-Conductor F. R. Vandyke, R.E., of the office, for the direct reproduction of drawings upon a zinc surface, without negatives or transfers, which was described in last year's Report, has been modified in some particulars and is now simpler than ever. A description of the changes introduced is being published amongst the Professional Papers of the Survey of India for this year. The process has been in daily use throughout the year, but has been almost entirely restricted to the reproduction of Bengal Cadastral maps. In April 1902, when this work ceases to be done in this office, the process will be more generally available. It is then proposed to utilise it for the reproduction of the regular Cadastral work of the department. The expensive, tedious and utterly unsuitable process by which these maps have been produced for many years past, involving as it does, the upkeep of a costly staff of photographers, is no longer necessary and should be abolished at the earliest possible moment. It will only be necessary to furnish this office with a tracing of each sheet, as has been done during the past year in the case of the Bengal sheets. Such tracings cost on an average about R1/- or R1/2/-each, including examination charges, and the charges incurred in this office for the preparation by the Vandyke process of the usual small number of copies would amount to about R2/. According to our present scale of charges for Cadastral maps, the same number of copies cost about R11/. In addition to the enormous saving that would thus be effected there are other advantages; the work turned out would be better and more legible; practically no corrections would be required on the zinc; and a very much larger quantity of work could be produced in a given time. Under the present system and with the existing establishment and photographic apparatus it is impossible to turn out more than 16 cadastral plates per diem by photo-zincography, and four or five by zincography from tracings in addition, and the work takes three days to complete. By the Vandyke process 30 or 40 plates, requiring no touching up by hand and ready for immediate printing, can be prepared daily with ease, and could be printed on the same day. Of course the printing of this number might entail some addition to the existing number of presses, but even this is not certain, as the plates are more easy to print than those prepared from transfers, of which the experience of the past year has given proof. Moreover the two presses now used for transferring and proving the cadastral sheets would no longer be required for this work and could be utilised for printing purposes.

The Government has purchased the right to use Sub-Conductor Vandyke's invention for a sum of R10,000. A specimen plate is attached to the end of this summary to give an idea of the quality of the results which the process is capable of producing.

61. In the *Map Record and Issue Office* the difficulty of keeping pace with the rapid accumulation of records is being more acutely felt every year.

The increasing number of original maps which continue to pour into this office, is choking up all available accommodation; under these circumstances the Curator has been driven to makeshift expedients which must eventually lead to confusion; many valuable records were being damaged by unsatisfactory storage, and others ran much danger of being eventually lost amongst unassorted heaps which were beginning to attain unmanageable dimensions.

Every effort is being made to remedy this state of affairs, and 2,000 new shelves have been provided as a first step towards establishing a more satisfactory system. Room was found for this addition by utilizing the space above the old racks and carrying them up to the roof; this region was formerly too dark to use, so a row of small clerestory windows had to be provided. Nearly all the 2-inch and 4-inch maps of the Punjab, Central Provinces, Burma, North-Western Provinces and Bombay are now satisfactorily stored, but this can only be regarded as a commencement, as it is impossible to carry out such changes otherwise than gradually with the available staff, without allowing current work to fall into confusion; even the work of clearing out maps to make space for the new racks, has hampered the office considerably, so that all hands have recently had to work overtime and on holidays almost continuously. The Assistant Surveyor-General in charge reports that they deserve all praise for the way they have faced the

situation, but men cannot be expected to maintain this high pressure indefinitely, and an increase of the staff to keep pace with the extra work will soon become inevitable. Very much more work of the same nature will be required before the arrangements for the proper storage of new maps, which continue to pour into the office, can be considered adequate or satisfactory.

62. About a quarter of a million of maps, having an aggregate cost of R275,881, was issued during the year, R10,105 being realised from private purchases.

The number of new maps received for publication was 8,038, of which 7,874 were cadastral sheets. Besides this over 6,000 original volumes, maps, etc., were issued from the office to other branches of the department and large number returned to store.

63. Great credit is due to Major Fleming, Assistant Surveyor-General in charge of this office, for the energy and ability he has shown in undertaking the very onerous work of rearranging and providing storage room for the maps which had accumulated far beyond the existing means of accommodation.

64. In the *Mathematical Instrument Office* the most important event of the year has been the preparation of a scheme to provide for the reorganization of the workshops on the principle of substituting a piece-work system for the present one of maintaining a fixed establishment of workmen on monthly wages. The sanction of Government was accorded to this proposal after the close of the year under report, and a change of this kind can only be introduced gradually; but it may be confidently expected that, under good management, a marked increase of economy and efficiency will result.

It is proposed to put an officer on special duty to supervise the inauguration of this system and to thoroughly overhaul the whole existing arrangements.

The office was originally started as an indispensible branch of the Survey Department, but is now extensively used by all the Civil and Military Departments of India; so that the outside work has become many times greater than that for the survey, although the latter has itself grown. In order to reap the full benefit of the elasticity which has been accorded to the workshops, it is most necessary that the whole organization should be somewhat remodelled with a due recognition of the nature of the work now required, so that the office may be able to deal promptly and efficiently with all demands made upon it, which has of late been a matter of increasing difficulty every year; it is hoped that these changes may be effected by reorganization rather than by increase of establishment. It will of course be impossible for the full benefits of the piece-work system, or even a large proportion of them, to become apparent during this transition period; but, by taking the main principles in hand at once as above proposed, it is likely that the eventual development will be more permanent and satisfactory.

65. The outturn does not differ very materially from that of the previous year, but the number of instruments dealt with has on the whole increased. The value of instruments issued and received, is, in each case, between two and a half and three lakhs of rupees, the issues being somewhat in excess of the receipts. Besides this, nearly six thousand instruments, or slightly more than last year, were put into repair for Public officers.

Over eight thousand repairable instruments were deposited in store; this is nearly twice as many as in the previous year; every effort is being made to reduce the large unwieldy stock of repairable instruments, and over 8,600 were made serviceable and issued, so that the net result for the year was a reduction of 411 in the number of instruments in the store.

With reference to this, it may be noted that the conversion and repair of old pattern Levels and Theodolites alluded to in paragraph 401 of last year's Report has steadily progressed, and during the year 165 Levels and 66 Theodolites were converted into serviceable instruments. This makes a total of 792 Levels and 365 Theodolites converted since the special establishment for this work was sanctioned, and all indents, except for special pattern Theodolites, have been complied with from this source; all indenting to England on this account has thus been avoided, but as the stock has run dangerously low, this will now have to be done to some extent, until it can be more rapidly replenished by the workshops. There is always a liability for unforeseen and urgent indents to

arrive, and any inability to comply promptly with them may cause serious and costly delay in the commencement of railway surveys or other such important undertakings.

The number of indents complied with was 1,499, showing an increase of about 4 per cent. on the previous year, and there has been some increase in the value of the workshops outturn, while on the other hand, the value of instruments indented for from England was £49,661, which is slightly less than last year, and the value of purchases in the local market also shows some decrease.

These figures are subject to very arbitrary fluctuations, but on the whole they show satisfactory efforts in the direction of economical working; without the freedom which the new system will afford no very great development in this respect could be expected.

BRANCH OFFICES.

66. The superintendence of the *Trigonometrical Branch Office*, Dehra Dún, was in the hands of Major S. G. Burrard, R.E., throughout the year. Mr. J. Eccles, M.A., held charge of the technical offices up to 20th February 1901, when he proceeded on leave after having made over charge of his duties to Mr. C. H. McA'Fee, who continued to be in charge to the end of the year.

67. Two Professional Papers, No. 3 "Method of Measuring Geodetic Bases by means of Colby's Compensated Bars," and No. 4 "Notes on the Calibration of Levels", were completed and issued; and the printing of the Tidal Volume, containing the details of the Tidal Observations taken during the period from 1873 to 1892 and a description of the methods of reduction, having been completed, it has been placed in the hands of the binders and will shortly be ready for publication. The Longitude Volume, containing the results of observations for re-determining the longitude of Madras from Greenwich, is being passed through the press. The compilation of the Levelling Volume, which is to contain the results of the levelling operations in India, has been begun.

A recalculation of the attraction of the Himalaya mountains upon the plumb-line has been made. The original calculation was made in 1854 by Archdeacon Pratt: the results of the two calculations give the following deflections of the plumb-line in the meridian :—

	1854.	1901.
At Dehra Dún	...	72″2
„ Kaliána	27″853	36″2
„ Kaliánpur	11″968	18″4
„ Dámargída	6″909	10″0
„ Cape Comorin		3″4

The problem of Himalayan attraction has never yet been solved; Archdeacon Pratt's conclusion was that a deficiency of matter was underlying the Himalayas and compensating their attractive effects, and in his view this great mountain mass exercised no influence on our plumb-lines. In recent times, however, large deflections have been observed in Sub-Himalayan regions, and these cannot be explained by the Archdeacon's theories. The deflection of the plumb-line at Dehra Dún has been found by actual observation to be 38″ greater than the deflection at Kaliánpur. A calculation of the effects of the superincumbent Himalayan mass based on the theory of gravitation shows that the deflection at Dehra Dún should be 54″ greater than at Kaliánpur. The observations at Dehra Dún do not therefore support the theory of a complete or even considerable compensation. On the other hand if the Himalayan mountains are exercising the great attraction that may be inferred from the observations in Sub-Himalayan regions, it is difficult to understand how no effects are visible in the Gangetic and Central Indian Plains. A classification of all available data was made during the summer of 1901: the results have been considered and will shortly be published in a professional paper.

68. On page 13 of the Annual Report for 1899-1900 allusion was made to the measurement of the Dehra Dún Base-Line with the Jäderin apparatus. The observations could not be reduced until the coefficients of expansion of the wires had been re-determined: the re-determinations were made at Dehra Dún during the winter of 1900-01 by Captain Lenox-Conyngham and are described

in Part II of this Report. With their aid the measurements of the Dehra Dún Base-Line have been reduced and are as follows:—

With the Jäderin wires:—

		Miles.	Yards.	Feet.	Inches.
1st measurement .	39187·171 =	7	742	1	2·052
2nd ,,	39187·373 =	·7	742	1	4·476

This gives a discrepancy of 0·202 feet, or 2·424 inches, which is equal to $\frac{1}{194,000}$th part of the length of the Base.

The mean of the above measurements is 39,187·272 feet, which is less than the very accurate determination made by Colonel Everest with Colby Compensation Bars in 1835 by 0·190 feet or $\frac{1}{206,000}$th part of the total length.

These results show that the apparatus will be probably fitted for use in Burma; a discrepancy of $\frac{1}{206,000}$th part of the length is however comparatively large, and an improvement is hoped for: the number of times, that the measurement of a Base-Line will have to be repeated with the Jäderin apparatus cannot be decided until more experience has been gained.

General Walker measured the Cape Comorin Base-Line four times with the Colby apparatus of Compensation Bars, and obtained the following results:—

1st measurement	8912·5926 feet.
2nd ,, ...	8912·5856 ,,
3rd ,, ...	8912·5892 ,,
4th ,, ...	8912·5943 ,,
Mean . .	8912·5904 feet.

The respective discrepancies between the four individual measurements and the mean were:—

0·0022 *feet* or	0·026 *inches* or	$\frac{1}{4,059,000}$ *part of total length.*
0·0048 or	0·058 or	$\frac{1}{1,860,000}$
0·0012 or	0·014 or	$\frac{1}{7,430,000}$
0·0039 or	0 047 or	$\frac{1}{2,390,000}$

Satisfactory as the first results with the Jäderin apparatus may be considered, their inferiority to those obtained with Colby's Bars is evident.

The advantages gained by the use of the Jäderin apparatus instead of the Compensation Bars are the rapidity with which the bases can be measured and the smallness of the party required to carry out the measurement. It has been found possible to measure with the Jäderin wires about 3,000 yards a day, whereas with the Compensation Bars the rate seldom exceeded 300 yards. A Jäderin Base-Line requires the presence of four Imperial and two Provincial officers, while a Base-Line measured with the Compensation Bars needs four Imperial and eight Provincial officers.

69. The Sub-Surveyor who accompanied the Archæological Research Party under Dr. Stein to Central Asia surveyed the country round Khotan and acquired valuable geographical information. His work and the exploration work of two other sub-surveyors who worked in the North-Eastern Frontier are being reduced.

70. The work in the Photo-Zincographic Section was heavier than usual. In addition to the reproduction of the maps of the Forest Department and standard maps, a heavy indent from the Quarter Master General is being worked out. Six hundred and eighty-three subjects were reproduced during the year, against 618 in the preceding year; and the outturn shows a number of 63 721 pulls against 55,536. The actual number of copies of maps, etc., was 46,995 against 44,270, and their value R26,584 against R20,376.

71. The usual meteorological and magnetic observations and the solar photography were continued. In the appendix a chart will be found giving an interesting comparison of the mean monthly temperatures at Dehra of (1) the air in the shade, (2) the ground at a depth of 12·8 feet below the surface and (3) at a depth of 25·6 feet below the surface. It will be noticed that the summer temperature reaches a depth of 12·8 feet three to four months after the time of greatest temperature on the surface, the winter temperature only lagging two months. At a depth of 25·6 feet the extremes of temperature are reached four to five months after the surface extremes, and the whole range is under 3°.

72. Three officers of the Imperial Service, Lieutenants A. A. McHarg, R.E., M. O'C. Tandy, R. E., and F. C. Hirst, I. S. C., went through a practical course of trigonometrical, topographical and astronomical work; and nine of the Provincial Service and 23 Sub-Surveyors were put through a course of topographical surveying and mapping.

73. The offices of the *Forest Surveys, Bengal Presidency*, at Dehra Dún, were employed, as usual, on correspondence and accounts, computations, area statements, mapping of field surveys, compilation of special maps and the upkeep of the records of the Forest Department. During the year 156 maps have been sent to press, 181 were in the press on the 30th September, and 319 are in different stages of progress. Four thousand, nine hundred eighty-four printed maps have been coloured and 2,702 mounted in book-form for Forest and other Civil officers.

74. *Local Drawing Offices.*—The system of locally compiling topographical maps on the 1-inch scale from old and miscellaneous material combined with the productions of the latest cadastral work, has gradually called into being several drawing offices whose work is carried on under the immediate superintendence of the survey officer in charge of the local cadastral party, and which are thus in a position to take advantage of all available local information. In so far as their work consists of topographical compilation it is charged to the Imperial revenues; and they also form a convenient centre to which special draftsmen can be attached when necessary to deal with miscellaneous cadastral work.

Of these the Bengal drawing office at Calcutta has this year been transferred from the charge of the head-quarter drawing office to that of the Superintendent, Provincial Surveys, Bengal; the outturn of work is detailed in the report on No. 4 Party in Part II.

The North-West Provinces drawing office under the Superintendent, Provincial Surveys, North-West Provinces and Oudh has carried on similar work in Naini Tal; details are given in the report of Nos. 2 and 8 Parties.

The Assam drawing office has been working on the same principle under the Superintendent, Provincial Surveys, Assam, and has been moved during the year to Shillong; its outturn is noted in the report on the Assam Detachment of which it forms a part.

75. Small drawing sections were maintained throughout the year by No. 17 Party and the Central Provinces Detachment, at Poona and Jubbulpore respectively. No. 18 Party had a section permanently employed at Simla on miscellaneous work; and in Bangalore the topograpical parties maintained an office with No. 21 Party to compile and bring up to date maps of Burma and the Eastern Frontier.

76. *The North-West Frontier drawing office*—under the superintendence of the officer in charge No. 15 Party—was employed as usual at Mussooree on transfrontier compilation, and a certain amount of miscellaneous work for the Intelligence Department. In addition to this a small amount of revision and correction of 1-inch Punjab maps was carried on, and a commencement has been made with three sheets of the new map of "India and adjacent countries" on the scale of one to a million.

ESTABLISHMENT.

77. The department has lost the services of two officers of the Imperial Service during the year.

Mr. G. B. Scott, Officiating Superintendent, 1st grade, and Superintendent, Provincial Surveys, North-Western Provinces and Oudh, retired from the service on the 31st July 1901. Mr. Scott joined the Revenue Branch of the Provincial service on 1st May 1863 and was promoted to the Imperial Service in November 1884. During his earlier service he was mainly conspicuous for his military services on and beyond the North-Western Frontier. From 1867 until the termination of the 2nd Afghán war, he was employed chiefly on trans-frontier and military survey operations, and for his gallantry and excellent services he was presented with a sword of honour and received two medals and several clasps. He was several times mentioned in despatches and his services were acknowledged by the Punjab Government, the Commander-in-Chief, the Viceroy and the Secretary

of State. He was recommended for a direct Commission as Captain in the Indian Staff Corps. Mr. Scott was attached to the Intelligence Branch of the Quarter Master General's Department on two occasions. From 1887 Mr. Scott held charge of important cadastral survey operations in Burma and in 1894 he was transferred to the North-Western Provinces to superintend the cadastral survey operations under the orders of the Local Government. He was in every way a most excellent officer and his able management of the large cadastral operations earned for him an extension of two years' service.

Captain H. J. Hare, R.E., Deputy Superintendent, 2nd grade, died on the 16th November 1900. He joined this department on 8th January 1893. During his short service, of nearly four years, he was mainly employed on Topographical Survey operations in Burma. During 1898-99 he served as Survey officer with the Burma-China Boundary Commission, and during the field season of 1899-1900 he carried on special survey work in the Irrawaddy Valley north of Myitkyina. His health had been far from good for some time past and he was granted privilege leave for a short change to Ceylon, where he died. Captain Hare was a very keen and promising officer and his loss will be much felt in the department.

78. In the Provincial service the department has lost the services of twelve officers during the year, *viz.*, by the retirement of Messrs. T. E. M. Claudius, W. C. Price, E. G. Little, H. Dowman, H. T. Hanby, C. D. Potter, J. A. Barker, G. D. Cusson, T. S. Marten, and C. W. Wilson, and by the deaths of Messrs. J. A. Higgs and W. H. D. Ewing.

PART II.

THE OPERATIONS OF THE SEVERAL FIELD PARTIES.

TRIGONOMETRICAL SURVEYS.

INDIA TRIANGULATION.

No. 24 Party.

79. The party remained under the charge of Captain H. H. Turner, R.E., until 10th April 1901, when he proceeded on furlough, and handed over to Lieutenant H. E. Wood, R.E. The latter availed himself of three months' privilege leave from 27th June 1901, and the charge during his absence devolved on Mr. J. Bond.

80. The party left recess quarters at Mussooree on October 12th and reached Sagaing, Upper Burma, on November 1st.

Here the party separated, as in the previous year, into two sections: one under Captain Turner, with the head-quarters, travelled by rail to Katha, there to start a new principal series—"The Great Salween"—which is to proceed eastwards from the base Katha H. S.—Ubyetaung H. S., a side of one of the figures of the Mandalay Meridional Series; while the other, under Lieutenant Wood, went by steamer to Kalewa on the river Chindwin, to continue the Manipur-Minor Meridional Series which had been commenced last year.

81. As no advance stations had been built for the new principal series, Captain Turner was delayed for some time at Katha, but he commenced observing on November 23rd, and, although much hindered by bad weather, completed the first figure, a tetragon, and observed six of the angles at two stations of the next. He also observed an astronomical azimuth at Simpitaung H. S. The country does not offer much difficulty for triangulation, but as the hills are densely clad with large tree jungle, the work of clearing the station sites is heavy.

Lieutenant Wood after a long journey by river and road began observing on November 20th. He was delayed during that month and December by the cloudy weather, thick mists blotting out the hills; but in January the weather improved, and work then proceeded rapidly.

The two final stations of the Mandalay Minor Longitudinal series (run last year) were connected to the Manipur series with satisfactory results, a mean difference of only 0″·02 in Latitude, 0″·03 in Longitude and 3″·6 in Azimuth being obtained between the values as computed by the two series. On February 22nd work was stopped by the smoke of the burning forests.

82. The party, with the exception of Mr. Hunter and a few men, reassembled at Rangoon and proceeded *viâ* Calcutta to recess quarters at Mussooree, where the office reopened on 27th March 1901.

Mr. Hunter remained for about six weeks in Burma exploring the following localities in order to discover sites for future base lines:—

(1) the Mansi district, about Latitude 24°·30′ and Longitude 95°·45′;
(2) Upper Chindwin district, in Latitude 24°·45′ and Longitude 95°·30′;
(3) the Meza Valley in Katha district;
(4) the Kyauksè district;
(5) the Sittang Valley in Toungoo.

The places which will probably prove suitable were found in the Kyauksè district and the Sittang Valley in the Toungoo district.

83. Captain Turner used Troughton and Simms' 12″ Theodolite No. 3, observing on 12 zeros with from 4 to 6 measures on each zero.

Lieutanant Wood worked with the sister instrument No. 2, and observed on 4 zeros with 4 to 6 measures each.

The season's outturn of work was as follows :—

Captain Turner's (Principal) Triangulation.

Number of stations newly fixed	3
Number of figures completed	1
Length of series completed, in miles	49
Area of triangulation, in square miles	1,730
Astronomical azimuths observed	1

Lieutenant Wood's (Minor) Triangulation.

Number of stations newly fixed	10
Number of figures completed	10
Length of series completed in miles	96
Area of triangulation, in square miles	1,850

Captain Turner's mean triangular error was o".57.
Lieutenant Wood's " " o".78.

84. The Superintendent, Trigonometrical Surveys, inspected the party in recess quarters at Mussooree on June 21st, 1901.

TOPOGRAPHICAL SURVEYS.

LOWER BURMA.

No. 3 Party.

85. Mr. E. Litchfield continued in charge of the party throughout the year.

86. The party left recess quarters at Bangalore on the 7th November 1900 and arrived at the head-quarters camp at Prome on the 16th. The field season was closed about the 20th May, and the office opened at Bangalore on the 3rd June 1901.

87. The party was divided into three camps. The head-quarters camp at Prome; camp No. I under Mr. Keating, in the Pegu district; and camp No. II, under Mr. George, in the Sandoway district. Mr. Donaghey was detached for the triangulation in Sheets 163 and 164 and Mr. Claudius for detail survey on the 1-inch scale in Sheet 159 in the Thayetmyo district. These two officers were under Mr. Litchfield's personal supervision.

88. The programme for the season, as modified, comprised :—

(*a*) The detail survey on the 1-inch scale of a strip of the Arakan Yomas, in the Sandoway district, situated between the crest of the Yomas on the east and Longitude 94° 30′ on the west; and of the unsurveyed areas in Sheets 118, 119, 120.

(*b*) The detail survey in the Thayetmyo district on the 1-inch scale of as much of Sheets 115 and 159 as possible.

(*c*) In the Pegu district the completion of the 2-inch survey of Sheets 259 and 260 and, if possible, of Sheets 261 and 262.

(*d*) Subsidiary triangulation in Standard Sheets 163 and 164 to assist the detail and revision survey of those sheets.

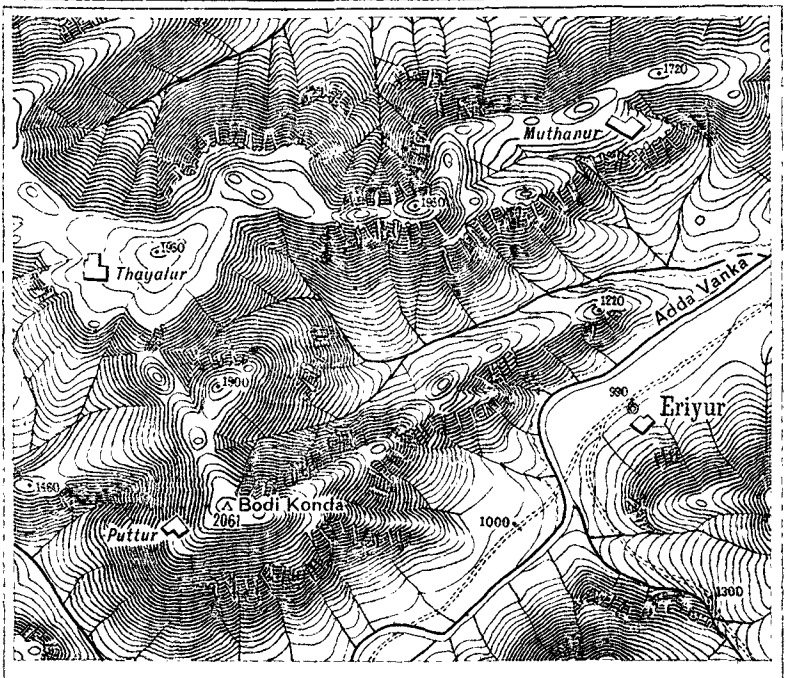
(*e*) Subsequently orders were received to complete the unsurveyed areas in Standard Sheets 253, 254, and 255 in the Toungoo district; and in March, on the completion of part of his triangulation, Mr. Donaghey, with Sub-Surveyor Mitchell, was sent to undertake the traversing required in those areas.

89. The outturn of the field season's work is as follows :—

	Sq. m.
Detail survey on the 1-inch scale	900
Revision " " " "	230
Detail " " 2-inch "	202
Triangulation	600
Traversing	74

The outturn compares unfavourably with that of the previous seasons, due primarily to an exceptionally unhealthy season, owing to which barely more than the equivalent of three and a half months' field work was obtained. It would seem advisable to alter the date of taking the field in these unhealthy localities,

SPECIMEN OF THE VANDYKE PROCESS.



This page has been entirely reproduced by the new Vandyke process, which is being generally brought into use for the reproduction of Cadastral Maps.

The original of this specimen having been drawn on thin Bank-post paper, the following is an estimate of the time and labour required for the whole process of reproduction:—

(1).—One man preparing the plate, half an hour.

(2).—Printing 500 copies in Machine Press, less than an hour.

For further particulars see para. 60, page 15, of this Report.

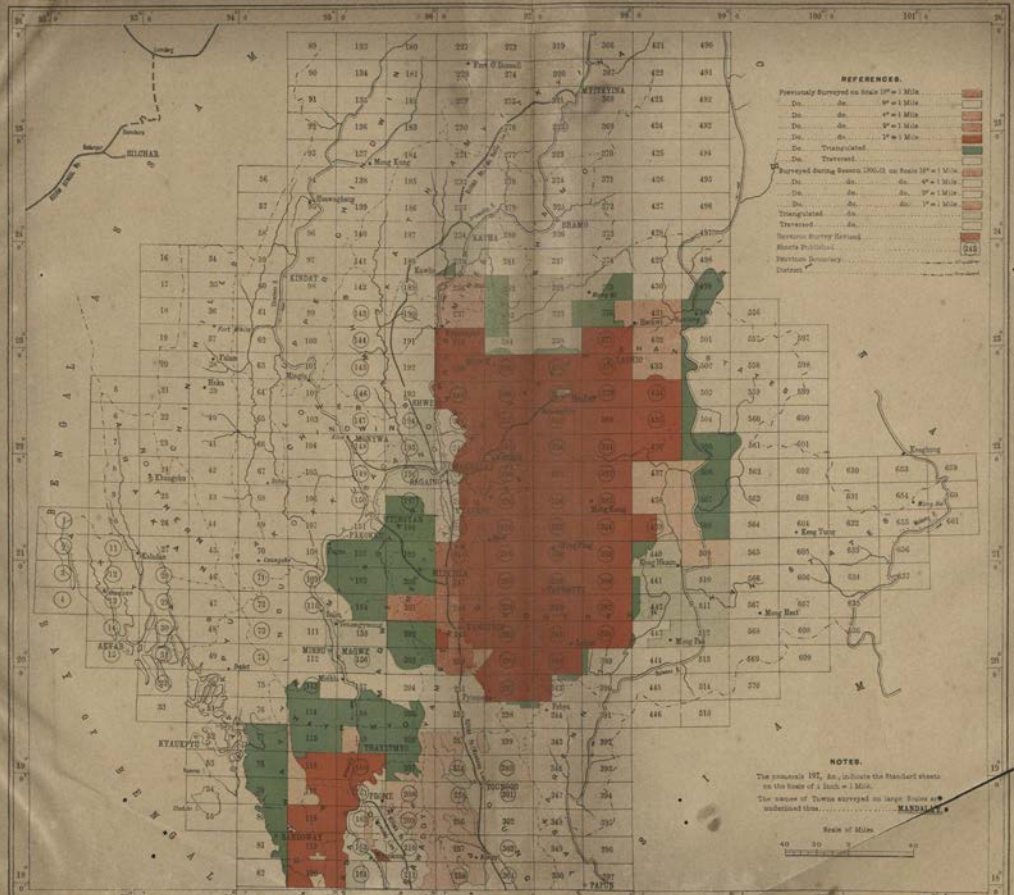
SURVEY OF INDIA OFFICES, CALCUTTA.

BURMA SURVEY.

INDEX TO THE SURVEY OPERATIONS IN BURMA NORTH OF LAT. 18°.

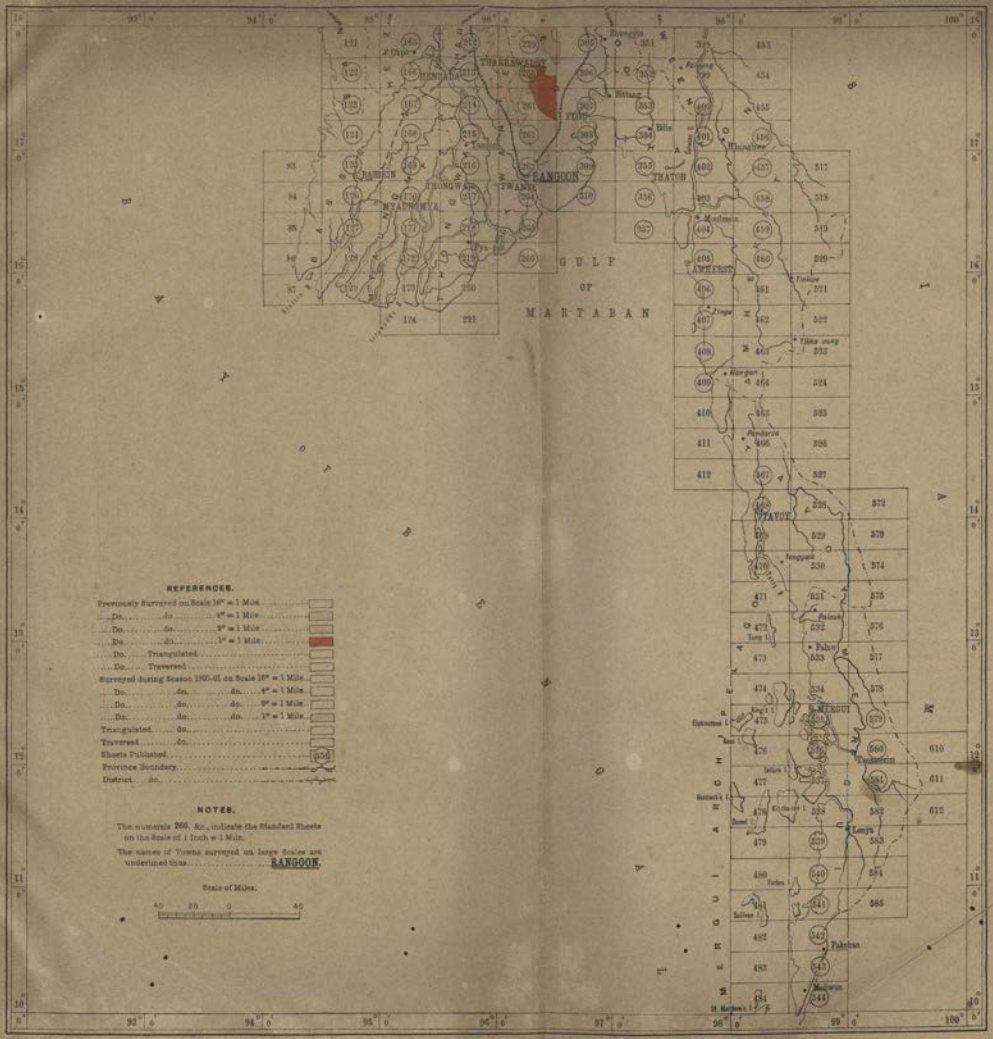
1900-01.

TOPOGRAPHICAL SURVEYS.


REFERENCES.
Previously Surveyed on Scale 16" = 1 Mile.
Do. do. 8" = 1 Mile.
Do. do. 4" = 1 Mile.
Do. do. 2" = 1 Mile.
Do. do. 1" = 1 Mile.
Do. Triangulated.
Do. Traversed.
Surveyed during Season 1900-01 on Scale 16" = 1 Mile.
Do. do. do. 8" = 1 Mile.
Do. do. do. 4" = 1 Mile.
Do. do. do. 2" = 1 Mile.
Do. do. do. 1" = 1 Mile.
Triangulated.
Traversed.
Previous Survey Extend.
Sheets Published.
Province Boundary.
District.
NOTES.
The numerals 197, &c., indicate the Standard sheets on the Scale of 1 Inch = 1 Mile.
The names of Towns surveyed on large Scales are underlined thus.
MANDALAY.
Scale of Miles
40 30 20 10 0 40
HILCHAR
Mong Kung
Kawnglung
KINDAT
KATHA
SHAMO
MOKWA
MYITKYINA
Kyaukpyu
Mong Hsu
Mong Pai
PAUNG
Kengtung
Keng Tung
Mong Yai
Mong Hsang
Mong Nai
Mong Pan
Mong Hkam
Mong Hsat
Mong Kaing
Mong Hkak
Mong Hsaing
Mong Hsu
Mong Hsaing
Mong Hsu
Mong Hsaing
Mong Hsu

BURMA SURVEY.

1900-01. INDEX TO THE SURVEY OPERATIONS IN BURMA SOUTH OF LAT. 18°. TOPOGRAPHICAL SURVEYS.



No. 409-S. 02.

and the local medical authorities will be consulted on this point. In such places the establishment becomes incapacitated and no more work is done in seven months than would be done in four under healthy conditions, while the expenditure continues making the cost-rates very high.

The total expenditure of the party is R89,889 and the cost-rates are as follows:—

Detail survey on the 1-inch scale . . .	R 43 per square mile.
" " " 2-inch " . . .	" 141 " "
Triangulation for 1-inch survey . . .	" 12 " "
Traversing	" 68 " "

90. No fair comparison can be made between these figures and those of last year. The detail survey represents virtually about three and a half months' work against six months' expenditure. The 2-inch survey was based entirely on traversing executed some years ago; only a few of the stations were found, and if the survey had been delayed another year a re-traverse would have been necessary. All the features were chained, no interpolation being possible and progress was necessarily slow.

91. The party suffered severely from malarial fever throughout the field season, which has been the most unhealthy experienced since its formation. In Pegu not one man escaped fever during the first 3½ months and for the remainder of the season all suffered more or less from its effects, and were unfit for hard work. In Sandoway things were no better; the daily average number of sick in the Toungup Hospital during January was 25; Mr. George, the Camp Officer, was seriously ill, and was found in an unconscious state by the Deputy Commissioner, who had him carried to the Toungup Hospital and telegraphed to Sandoway for the Civil Surgeon. Four men died, and many returned to their homes completely broken in health. Of the sub-surveyors recessing at Bangalore several are still ill and are undergoing treatment. Work cannot progress satisfactorily under such circumstances and in future measures will be adopted to avoid this danger as far as possible, and, by taking the field a month or so later when working in unhealthy tracts, it is hoped that some immunity may be secured.

The conditions for 1901-02 are more hopeful. The country to be surveyed in Thayetmyo and in Pegu is easier, more open and better populated; and the climate is drier and, it is hoped, healthier.

92. In the Sandoway district the country surveyed was similar to that previously described, but was confined to a strip near the crest of the Yomas, which was separated from the nearest villages by a belt of dense forest and undergrowth, about 25 miles in width, devoid of roads or paths. To keep down the expenditure the number of *khalasis* imported had been reduced; they were to be supplemented, when necessary, by local labour. But it was found that owing to the inaccessibility of the country to be traversed, and to the fact that it was harvest time, it was almost impossible in the early part of the season to obtain labour and as no other class of transport was available or practicable a considerable amount of trouble and much delay ensued.

The area surveyed in Pegu is in general character similar to that of last year; but it is uninhabited and wild. There is only one cart track, about five miles in length, entering it from Bawni, and the few paths which exist are generally confined to the beds of streams and the crests of spurs. There are no permanent villages, only a few temporary *Karen* camps.

As supplies were not obtainable locally either in the Pegu or Sandoway districts, these were imported from the nearest large towns and stored in depôts for distribution.

In both districts wild animals were numerous and were the cause of a good deal of nervousness on the part of the establishment. Again this year a *khalasi* was mauled by a bear in the Pegu district.

93. The 1-inch standard sheets are being drawn for publication in two colours. Eight sheets are in hand, of which seven will be completed within the next few months.

Ten 2-inch sections of Sheets 259, 260 and 261 are in hand; these are being drawn for reduction in one colour. Eight are complete as regards the new surveys executed by this party, the compilation of those portions of them surveyed by other parties is in hand.

Eight charts are in hand, complete as regards the work of this party, but awaiting the addition of that of other parties.

The computations will be completed before the party leaves for the field.

94. The programme for 1901-02 comprises—

(*a*) the triangulation for the topographical revision in the field of Sheet 262 and of the eastern halves of Sheets 253, 254 and 255 compiled from the cadastral map; and, if time permits, the extension of the previous season's triangulation into Sheets 113 157, and 204;

(*b*) the completion of the unsurveyed areas in Standard Sheets 115 159, 206, and 207, Thayetmyo district, on the 1-inch scale;

(*c*) the completion of the survey on the 2-inch scale of Sheets 253, 254, and 255 in Toungoo, and of Sheets 261 and 262 on the 1-inch scale in Pegu. The total area for survey being 620 square miles, while 1,730 square miles of topography obtained from the cadastral reductions has to be examined and supplemented, and it is doubtful whether this programme will be completed.

95. The party was inspected in the field by Colonel Hobday, Deputy Surveyor-General, at Toungoo, Thayetmyo and Prome in March, and again at Bangalore in September by Major Longe, Officiating Deputy Surveyor-General.

UPPER BURMA.

No. 10 Party.

96. Captain F. W. Pirrie, I.S.C., was in charge of the party throughout the year; Lieutenant Rich, R. E., who was attached as an assistant, being transferred to the charge of No. 21 Party during the season.

97. The survey operations were of the same nature as in the year 1899-1900, and consisted of 1-inch topographical surveys in the Ruby Mines, Shwebo, and Yamèthin districts of Upper Burma, as well as portions of the adjoining Shan States to the east; revision of topographical detail on 1-inch reductions from cadastral surveys was carried on in the Meiktila, Yamèthin and Magwe districts.

98. Water is always scarce in the Ruby Mines and adjoining districts after February, so this portion of the 1-inch survey had to be taken up and completed as early in the season as possible. Owing to the amount of forest and the intricate nature of the country, the work was not completed till the end of March, when great difficulty was found in obtaining water. It was carried out in a very satisfactory manner.

99. Owing to the difference in the amount of topographical detail shewn in the various revenue reductions, and the different methods of shewing the same kind of ground in adjoining districts, it was quite impossible to tell from looking at these maps what amount of resurvey would be necessary in order to make them useful to the general public. Again, as a rule, all indication of the hills has been entirely omitted; in only a few isolated cases was the word "hills" shewn on the revenue reductions where hills existed. This was particularly so in parts of the Yamèthin district where the hills were often high enough to prevent all local communications; if these were omitted in published maps, they would be practically valueless for any one finding his way through the country. The result was that the whole of the ground had to be carefully examined.

100. The officer in charge and his senior assistants thoroughly tested on the ground the work of the surveyors employed on both detail and revision surveys.

101. The outturn for the field season was as follows:—

	Square miles.
Triangulation	4,068
Detail survey on 1-inch scale	1,285
Revision survey	2,023

The cost-rates per square mile were as follows:—

	₹	a.	p.
Triangulation	4	15	0
Detail survey on 1-inch scale	26	4	0
Revision of topography in Revenue Surveys	22	5	0

102. Triangulation was carried on in parts of Magwe, Minbu, Sagaing, Mônywa, Shwebo and Katha districts, and embraced the remaining portions of Sheets 197 and 235, the whole of Sheets 156, 155, 196, 195, 234 and portions of 112, 111 and 194.

103. The new 1-inch detail survey completed during the field season comprises an area of 1,286 square miles in Sheets 236, 237, 250 and 296, chiefly in the Ruby Mines, but partly in Shwebo, Katha and Yamèthin districts.

104. The revision survey comprises an area of 2,023 square miles, and is made up of the western portions of Sheets 246, 247, 248 and 249 which had been partially revised in the previous season, the whole of Sheet 201 and the north-western portion of 250.

105. Owing to the hilly and more intricate nature of the country falling in the revision survey during this field season, a great deal more care and supervision was necessary in carrying out the work than was the case last year. The total area surveyed by the party is about the same as in the last field season, the detail survey being less, and the revision survey being more.

106. The health of the party during the field season was good, except in the months of November and December, when there was a good deal of malarial fever, especially in the Ruby Mines and Katha districts.

107. During the recess the greater portion of the computations have been completed and two triangulation charts were begun, but owing to insufficient data could not be completed. Standard Sheets 246, 247, 248, 249, 250, 201, 236, and 237 were completed. All available data for fair drawing standard Sheets 238, 239, 240, 243 and 244 were sent to the Drawing Office, Calcutta, but the editions of 243 and 244 can but be preliminary as the western halves have been accepted from the revenue reductions without subsequent revision in the field.

108. The programme for the next field season is as follows:—

The triangulation of standard Sheet 110 and the remaining portions of 254, 203, 112, 111, 109, 108 and 151. A secondary series will be run connecting the G. T. Mandalay Meridional series near Katha with the secondary G. T. Manipur Meridional series near Kindat for the future extension of topographical triangulation, and to provide stations and points for the forest survey traverses between those G. T. series. As a matter of secondary importance a connection will be made with No. 14 Party's triangulation west of Fort White, and other existing triangulation near Kindat. No new detail survey will be taken up. Revision survey of the topography in revenue reductions which comprise standard Sheets 202, 203, 156, 155, 154, 153 and 200, and if there is time towards the close of the field season the remaining revenue portions of 241 and 245.

109. The party was inspected by the Surveyor-General in the field in February and during recess in September. He was well pleased with the state of the party and especially with Captain Pirrie's conduct of the revision operations, a work which is new and somewhat experimental.

UPPER BURMA.

No. 11 Party.

110. The party remained under charge of Mr. P. J. Doran, Extra Assistant Superintendent, throughout the year. He had the assistance of 4 Provincial officers and 16 surveyors.

111. During the season under report the party continued the topography on the 1-inch scale in Sheets Nos. 437 to 439 and 506 to 509, embracing portions of the Northern and Southern Shan States. The country to the east of the Salween river falling in the Northern Shan States and its immediate vicinity, *viz.*, Sheets 506 to 508 was for political reasons forbidden ground, and this the party left unsurveyed.

The outturn for the field season was as follows:—

	Square miles.
Triangulation	3,311
Detail survey on the 1-inch scale .	2,472

The amount of work done, both triangulation and topography, is very satisfactory considering the nature of the country. The work was also a good

deal hampered by the heavy fogs which prevail in the neighbourhood of the Salween during a great portion of the year.

The surveyors were constantly visited and their work closely tested.

112. The country surveyed in detail, as well as the portions triangulated, consisted mostly of high hills and undulating low ground. The higher hills are covered with large trees and fairly free of undergrowth; on the low ground however, except when cultivated, the cover consists of a dense mass of shrub, elephant-grass, and bamboo jungle, and is especially thick on the river banks. Notwithstanding this there is a very considerable population in all the country west of the Salween, and a great deal of rice cultivation carried on, mainly on the *Jhoom* System. Far more rice is produced than required for local consumption and the balance is exported.

113. The party started from Bangalore for the field at the end of October 1900, and returned at the end of May 1901.

114. The triangulation fell a little short of the programme owing to the death of Surveyor J. Sebastian in the early part of the year. The party lost a very valuable hand when this officer, after but a few days' illness, was carried off by malarial fever.

Again the illness of Probationary Sub-Surveyor Sadik Hossein, at the best time of the year for observations, prevented the completion of the work. Mr. Gorman went to this sub-surveyor's help after finishing his own work, but he also fell ill and was disabled for further work of any kind for the rest of the season. Two of the menials died and the number ill with malarial fever during the season was greater than usual.

115. The recess work has been well brought up. The fair mapping of Sheets Nos. 436 to 439 and No. 509, also portion of Sheets Nos. 506 to 508 has been completed for publication in two colours. All the computations except the Latitudes and Longitudes of intersected points of two sheets have been finished. The charts alone remain to be done.

116. As the greater portion of the valuable and well populated parts of the Shan States has now been surveyed, it has been decided to amalgamate Nos. 11 and 21 parties, reducing the strength. A programme has been arranged by which such remaining portions of the country which, on account of their population or other reasons, are worth surveying on the 1-inch scale will be thus mapped. A considerable section of the party will be employed in surveying on the $\frac{1}{4}$-inch scale such portions of the country as still remain blank on our maps or which have hitherto been only very imperfectly reconnoitred.

In accordance with this the following programme has been arranged:—

On the 1-inch scale.—Sheets 440 to 442 and the ground falling to the west of the Salween river, of Sheets Nos. 510 to 512; the completion of the triangulation and detail survey of Sheet 443; and advance triangulation of 389, 444, and that portion of 512 which falls to the west of the Salween River.

On the $\frac{1}{4}$-inch scale.—The detail survey of the country to the east of the Salween falling in Sheets 506, 507, 508, 510, 511 and 512; triangulation as much as can be done in Sheets 562 to 565 and 602 to 605.

117. The Surveyor-General inspected the party in September and was well satisfied with the state of its work.

UPPER BURMA.

No. 21 PARTY.

118. In the previous year the late Captain Hare, R.E., was in charge of the party, but fell ill just before the commencement of the field season. After a short interval, during which Mr. Hamer held charge, the party was handed over to Mr. A. J. James, who thus had to take over the duties at a most awkward time. Towards the end of the field season Mr. James' failing health necessitated the transfer of Lieutenant E. T. Rich, R.E., to the party. Lieutenant Rich held charge until late in June, when he himself fell ill and was invalided home. Lieutenant E. A. Tandy, R.E., was then transferred to the party, Mr. W. Stotesbury taking charge until his arrival. Lieutenant Tandy remained in charge until the end of the recess.

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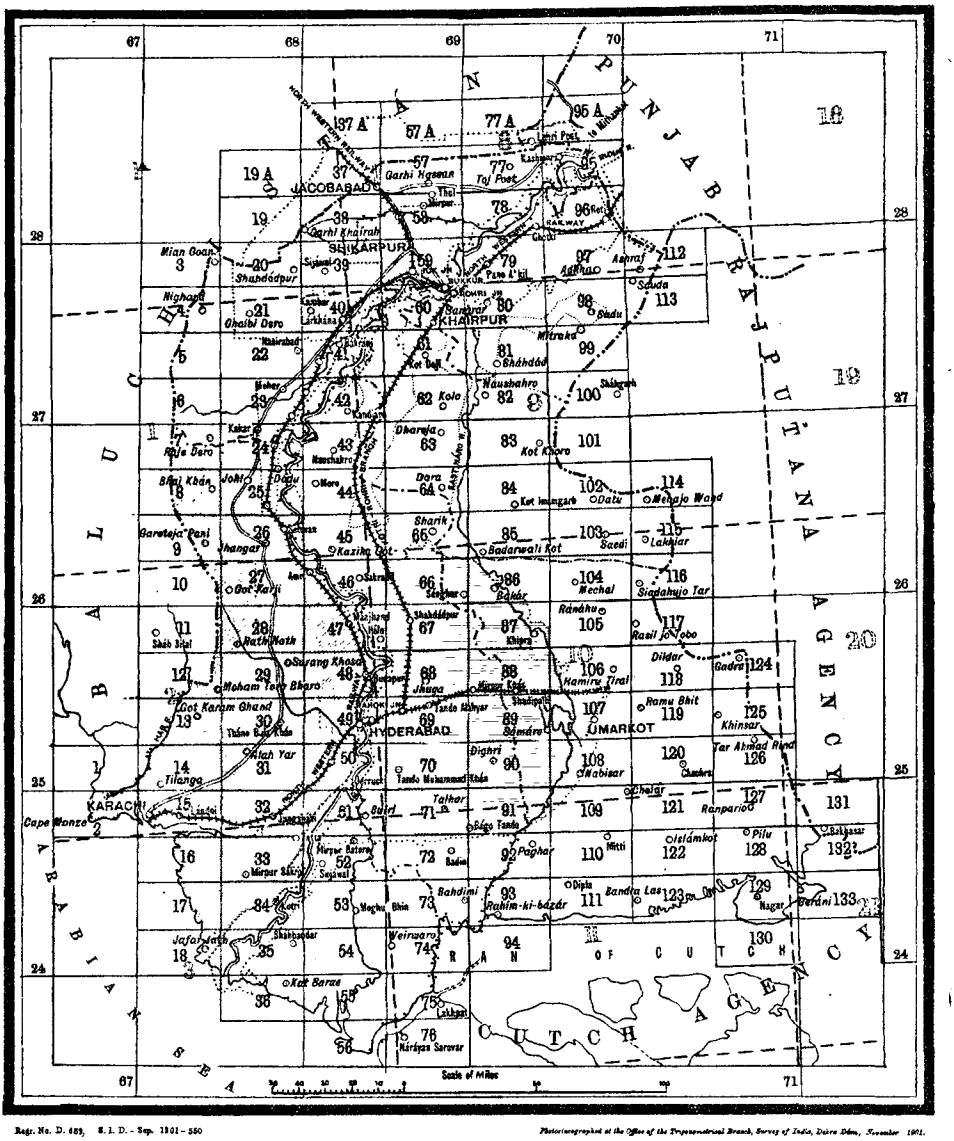


Regr. No. D. 689, S. I. D. – Sep. 1901 – 550

Photozincographed at the Office of the Trigonometrical Branch, Survey of India, Dehra Dún, November 1901.

REFERENCES.

NO. 226-S. 01.

Surveyed in previous Seasons Scale 1" = 1 Mile by No. 15 Party .....

Do. ..... do. ..... 2" = 1 Mile ..... do. .....

Do. ..... do. ..... 4" = 1 Mile ..... do. .....

Do. 1900-1901 ..... 2" = 1 Mile ..... do. .....

Do. ..... do. ..... 4" = 1 Mile ..... do. .....

Triangulated and Traversed in advance ..... do. .....

Surveyed in previous Seasons Scale 1" = 1 Mile by No. 15 Party .....

Do. 1900-1901 ..... 1" = 1 Mile ..... do. .....

Triangulated in advance ..... do. .....

Indus Riverain Survey .....

NOTES.

The numerals 63, etc., indicate the Standard sheets on the Scale 1 Inch per 1 Mile.

The figures and lines in strokes represent the numbers and limits of the Engraved sheets of the Indian Atlas.

Photogravure.

Survey of India Offices, Calcutta, February 1902.

THE SIND DESERT.

Enlarged from a negative by Mr. E. C. J. Bond.

119. The party which took the field under the officer in charge consisted of 1 extra assistant superintendent in charge of the 1-inch detail survey, 3 sub-assistant superintendents triangulating, 13 surveyors and sub-surveyors, 1 writer, 1 hospital assistant and 225 menials.

120. During the season the topographical survey, on the 1-inch scale of the Northern Shan States to the east and north of Lashio was resumed; and in addition the large scale survey of the town and environs of Hsi Paw on the Mandalay-Kunlong Railway was completed.

The total outturn of the party was as follows:—

Triangulation for 1-inch detail	3,375 square miles.
Detail survey on 1 „ scale	1,793 „ „
HsiPaw survey on 16 „ scale	4,885 acres.

In addition to this, a great deal of compilation of China, and Upper Burma maps has been carried out by the Bangalore Drawing Office. The country surveyed was all hilly, varying in elevation from 2,000 to 7,000 feet, thickly wooded and well populated; moving about was everywhere fairly easy owing to the several mule tracks and many footpaths which traverse the country.

121. The outturn inevitably suffered somewhat from all the changes in the charge of the party, and the cost-rates are accordingly somewhat higher than they should have been. They are as follows:—

Triangulation for 1-inch detail	R7·5 per square mile.
Detail survey on 1-inch scale	R21.4 „ „ „

The cost of the 16-inch survey was much enhanced by the employment of several assistants and others on the detail work for instructional purposes, and also by the accurate survey of an immense amount of detail which would not generally be attempted on this scale. This was done at the request of the local authorities for whom the map has been made, and the result is a most accurate and trustworthy but somewhat costly plan.

122. The party left recess quarters at the end of October 1900 and returned at the end of May. The general health was good and the season uneventful. The fair mapping and computation of the work done in the field will be completed by the end of recess. The three complete 1-inch sheets surveyed during the season and all the Hsi Paw sheets will be ready for publication this year, and the triangulation charts of the party are being brought up to date as quickly as possible.

123. As has been mentioned under the head of No. 11 Party, these two parties have been amalgamated and will in future work as one.

124. The party was inspected by the Surveyor-General in September.

SIND.

No. 12 Party.

125. The operations during the year under report were in continuation of those of the previous season. Mr. C. F. Erskine continued in charge of the party.

126. The following programme was completed:—

(*a*) Three series of secondary triangulation, two of which were 70 miles in length and one 40, and also a net-work covering the whole of the Khairpur State lying east of the Nára river.

(*b*) Village boundary traverse survey in portions of Sheets Nos. 41 and 60; together with an area of about 3,000 square miles in the Khairpur State, where the village boundaries are not demarcated.

(*c*) The detail survey on the 2-inch scale of portions of Sheets Nos. 39, 40, 41, 58, 59, 60, 61, 77, 78 and 95.

(*d*) The survey of the Karáchi cantonments on the 12-inch scale was also completed.

127. The recess office at Karáchi was closed on the 28th October 1900, and the party reassembled at Sukkur on the 3rd November, and each man was on his ground by the end of the second week in November.

128. The traversing in British territory consists, as in former years, of a village boundary survey with offsets, and in the Khairpur State, where the village

boundaries are undemarcated, of a series of main and sub-circuits divided into blocks by connecting lines. There were 7½ main circuits measured, 13 sub-circuits and 48 village circuits. The angular work was checked by observations for azimuth at 99 stations on main and sub-circuits, the average angular error per station being 49″. The linear measurements amounted to 2299 miles, and were checked by 75 connections with principal stations of the Eastern Sind Meridional Series, with stations of the Sehwán Series and those of the series run during the year under report.

The average correction per 1,000 links was 1·2 links. No permanent marks were laid down at traverse stations, but the marks erected by the Revenue authorities to demarcate village boundaries have been utilized, and the angles of village boundaries have been fixed by offsets; every fifth station has also been marked by an earthen pillar sufficiently large to be easily picked up by the detail surveyors.

In addition to the foregoing traverse operations, 74 bench marks laid down by the Railway Department were connected with the traversing; this involved observations at 176 stations, and 24 linear miles of chain measurement. The cost of the traverse survey amounts to R6·7 per square mile.

129. The area surveyed in detail on the 2-inch scale amounts to 2,553 square miles, giving 70 plane-table sections. The survey was carried out almost entirely by interpolation, and was based mainly on the traversing; it was tested from 416 *in situ* fixings, and was carried out under the direct supervision of the officer in charge. The cost of detail survey is R12 per square mile.

130. The survey of the Karáchi cantonments was completed early in the field season; the area surveyed has been fair drawn and the maps despatched to the Trigonometrical Office, Dehra Dún, for publication.

131. Field work closed early in April and the party returned to Karáchi for recess. During recess the fair mapping of the entire area surveyed in detail on the 2-inch scale was completed; the mapping was comprised of 28 quarter sections. They were drawn on the 2-inch scale for reduction and reproduction, and have all been despatched to the Trigonometrical Office, Dehra Dún, for publication.

The triangulation and traverse charts of Sheets Nos. 60, 77, 83, 84, 85, 95, 103, 114 and 115 have been drawn. All the charts with the lists of co-ordinates have been despatched to Dehra Dún.

132. Next season triangulation and traversing in advance will be taken up in Sheets Nos. 24, 25, 41, 42, 43, 44, 45, 46, 61, 62, 63, 64, 65, 81, 82, 99 and 100.

133. Detail survey will be carried on in Sheets Nos. 42, 61, 62, 63, 64, 82, 83, 84, 85, 102, 103, 114, 115 and 116.

134. The Party was inspected by the Superintendent, Trigonometrical Surveys.

LUSHAI HILLS, ASSAM.

No. 14 Party.

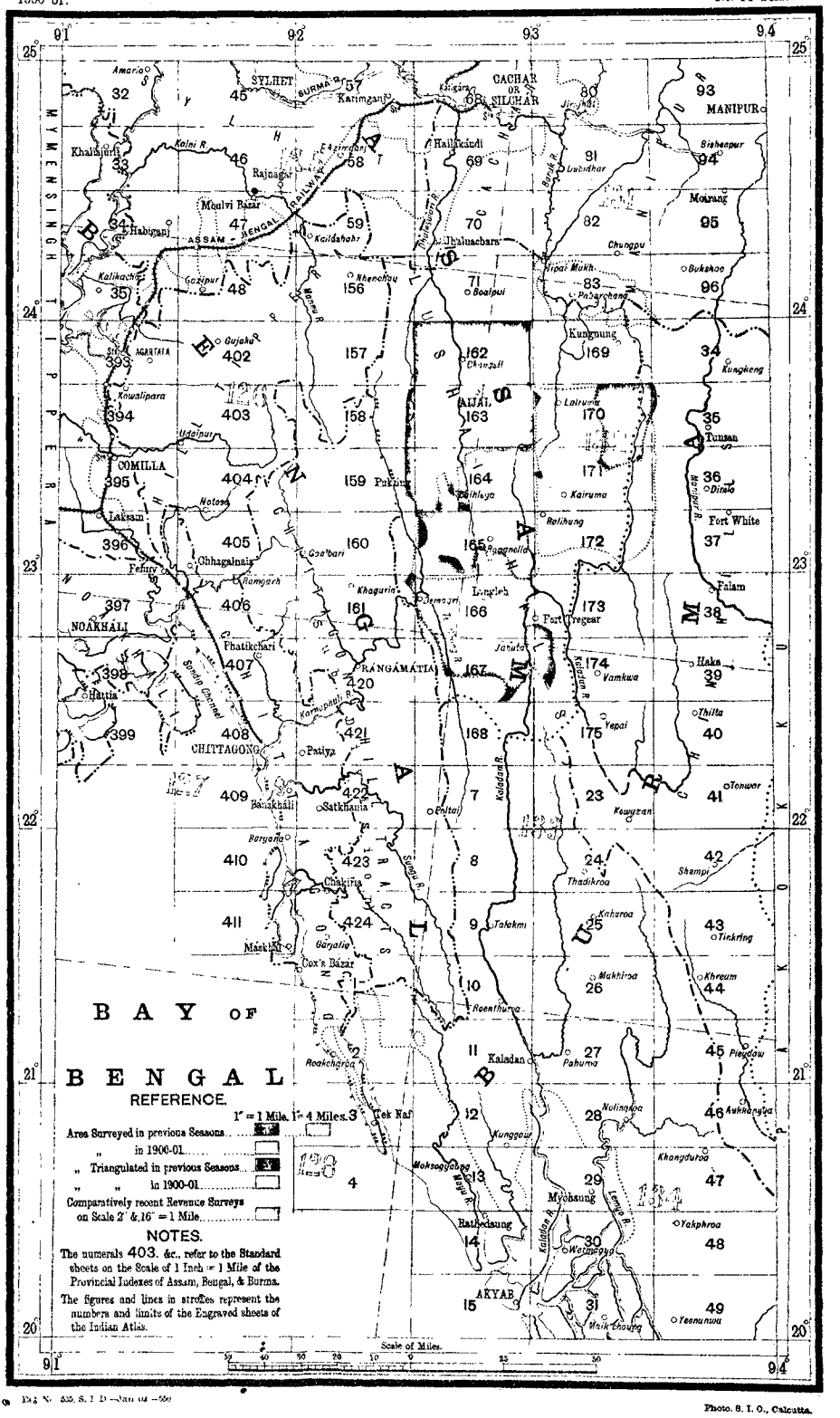
135. Captain C. L. Robertson, R.E., was in charge of the party till the 19th July 1901, on which date he made over to Lieutenant C. P. Gunter, R.E., who held charge till the break-up of the party in October 1901.

136. The party left Shillong on 23rd October 1900 and travelled to the field *viâ* Goalundo and Silchar. The party returned by the same route at the close of the field season on the 10th April, and the recess office was opened in Shillong on 20th May 1901.

137. The triangulation this season consisted of Tertiary Triangulation in Sheets 170, 171, and 172 and the extension of the First Class Secondary Series into Sheet 171. The computations of the tertiary work in Sheet 170 and of the First Class extension have proved well; those of work in Sheets 171 and 172 have not been completed. The Topographical survey on the 1-inch scale of Sheets 164 and 165 was completed with the exception of a few gaps in the latter which could not be surveyed for want of time and owing to the sickness of two sub-surveyors. Both sheets have been fair drawn and made ready for publication.

INDEX TO THE TOPOGL. SURVEY OF THE LUSHAI HILLS.

1900-01. No. 14 PARTY.



REFERENCE.

1" = 1 Mile. 1" = 4 Miles.

Area Surveyed in previous Seasons.....

" in 1900-01.....

" Triangulated in previous Seasons.....

" " in 1900-01.....

Comparatively recent Revenue Surveys on Scale 2" & 16" = 1 Mile.....

NOTES.

The numerals 403. &c., refer to the Standard sheets on the Scale of 1 Inch = 1 Mile of the Provincial Indexes of Assam, Bengal, & Burma.

The figures and lines in strokes represent the numbers and limits of the Engraved sheets of the Indian Atlas.

Ex. N. 535. S. 1 D.—Jan. 02.—550

Photo. S. I. O., Calcutta.

No. 401-S. 02.

138. The outturn for the season was as follows :—

	Square miles.
First class secondary triangulation—3 new stations fixed.	
Tertiary triangulation	1,122
Detail survey on 1-inch scale	870

139. The cost-rates were R28 per square mile for tertiary triangulation and R68 for detail survey.

140. The health of the party during the field season under report has not been good, and the returns show an increase of sickness compared with last year. Cholera broke out amongst the Khásia coolies entertained at Silchar, on the way to the field, and 20 deaths occurred from it, mostly on the march between Silchar and Aijal, besides 5 deaths from other causes. Every care was taken to safeguard the health of the men, and a hospital was built for them at the field head-quarters; the high rate of sickness is attributable to the general unhealthiness of the country in the valleys and to the poor physique of most of the imported coolies.

141. The country surveyed and the difficulties of survey are similar to those described in the report on the operations in 1898-99. In addition great difficulties were experienced in the low valleys in the south-east of Sheet 165. As in previous years, coolie transport alone was utilized; it consisted of 100 Gurkhas from the Darjeeling district, 150 Khásis from the Khási Hills, and local Lushais. The Lushais worked well and proved a great success, and in future years should be obtainable in sufficient numbers for the whole requirements of a party. Rations for the whole party, with the exception of local rice, had to be imported and distributed from head-quarters to the various detachments.

142. During the four years it has been employed in the Lushai Hills this party has completed over 2,000 square miles of detail survey on the 1-inch scale, and has triangulated nearly the same area in advance, besides carrying out some $\frac{1}{4}$-inch boundary work and making a complete survey of Aijal on the 24-inch scale.

143. As the survey of the more important portion of the Lushai country has now been completed, it has been determined to transfer this party to the North-Western Provinces to take up the topographical survey of certain districts, of which no maps are at present available.

144. The recess office of the party was inspected by Major F. B. Longe, R.E., Officiating Deputy Surveyor General at Shillong in May.

NORTH-WESTERN FRONTIER.

No. 15 Party.

145. Colonel R. A. Wahab, C.I.E., R.E., held charge of the party from the beginning of the year till the 17th April; when, having made over charge to Captain G. A. Beazeley, R.E., he proceeded on 7 months' leave to Europe. Captain Beazeley on leaving Mussooree for Kashmir on duty made over charge of the party to Mr. E. A. Wainright on the 9th May.

146. The several detachments left recess quarters about the end of October, the Kashmir detachment returning about that time and retaking the field early in May. The Sind party returned in April, and the Kashmir detachments are still in the field.

147. The party was divided into the following detachments :—one under Captain Beazeley, working in Kashmir, Chilás and neighbourhood, one in Sind under Mr. Freeman, and a section of draftsmen under Mr. Wainright, working up arrears of mapping, was left in Mussooree during the winter.

An Assistant and a computer have been sent on traverse work in connection with the settlement of the Hindubágh and Bori valleys, Balúchistán. Mr. Knight has been sent to supplement the triangulation of the Khojak Range of hills, and other members of the party were employed on special duties.

148. The programme submitted in last year's report has been carried out.

In Sind the following standard sheets were completed—8, 10, 11, 27, 28, 47, 48 and 49. No triangulation was extended in this district.

The Kashmir programme included the extension of ½-inch survey, a good deal of revision of previous year's survey, and the strengthening and extension of triangulation.

149. During recess a large amount of fair mapping has been got through, leaving now only one sheet of Sind untouched; while 6 charts of Balúchistán and Sind surveys have been compiled and drawn.

150. The total outturn of work of the party is as follows :—

	Sq. miles.
Triangulation for ½-inch survey	4,800
Detail survey ½-inch	3,324
" " 1-inch	1,915
" " 2-inch	440
" " 12-inch	32
Reconnaissance ¼-inch & ⅛-inch	17,000
Tringulation for do.	18,000

151. The programme for the ensuing season includes the detail 1-inch survey and triangulation in Sind; the continuation of the ½-inch survey and triangulation in Kashmir and Gilghit Agency during the hot weather; the Sind detachment will move up to Balúchistán in the spring for detail survey.

This party is also taking up the 12-inch surveys of military cantonments and the mapping of *bazars* which have been necessitated by the new Cantonment Act, and a commencement will be made with those at Cawnpore, Agra, Lucknow and Fatehgarh.

152. With the exception of one sub-surveyor, who died of pneumonia in Kashmir, there have been no casualties and the health of the party has been good.

153. The office of the party, at Mussooree, was personally inspected by the Surveyor-General in August.

HIMALAYAS, PUNJAB.

No. 18 Party.

154. Major W. J. Bythell, R.E., remained in charge of the party throughout the year, and Lieutenants A. A. McHarg, R.E., and M.O'C. Tandy, R.E., joined it in November, with a view to undergoing a course of instruction in plane-tabling.

155. The work of the party was similar to that of previous years, and the programme provided for the completion of the surveys of the allotted area. With this view the party was divided into two detachments, one for work on the 1-inch scale in the Kullu, and the other on the 2-inch scale in the Hoshiárpur district.

156. The Kullu detachment under Mr. Greiff consisted of Mr. Biggie and nine sub-surveyors; it left recess quarters on the 24th of August and was employed in Kullu until the beginning of December, and on the completion of its work there proceeded to the Hoshiárpur district *viâ* Mandi, and took up detail survey on the 2-inch scale. This detachment carried out its work in the face of considerable difficulties, resulting from continued bad weather, and the rugged nature, and high altitude (varying from 14,000 to 20,000) of the *locale* of its operations.

The Hoshiárpur detachment of 15 sub-surveyors under Mr. Robert left Simla on the 30th of November, and was employed on 2-inch detail survey throughout the field season. The area surveyed consisted chiefly of the outer Siwálik range, a mass of intricate and very broken ground, intersected in every direction by narrow ravines and *nalas* with steep and lofty sides.

The survey of the district was completed on dates varying from the 20th May to the 15th June when the party returned to recess quarters.

157. A Drawing Office of 15 draftsmen, to which four of the field surveyors were temporarily attached, remained in Simla throughout the field season to carry on the mapping work of the party.

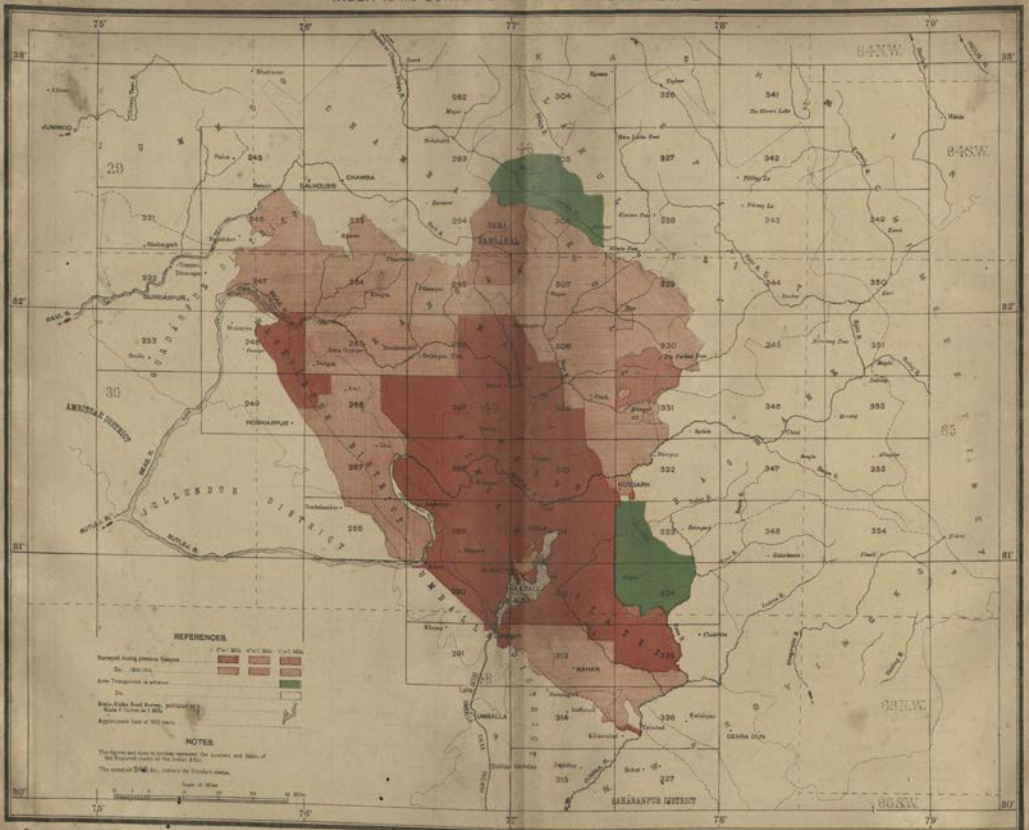
Mr. Parker was in charge up to the 15th November and on his proceeding on three months' privilege leave, Mr. Potter, who had received six months' extension of service, supervised the section until he retired from the service on the 16th February 1901.

PUNJAB SURVEY

1900-1901

INDEX TO THE SURVEY OPERATIONS IN THE HIMALAYAS

NO. 18 PART I.



NO. 211-S. 01.

158. No new triangulation was carried out during the season under report, but Mr. Biggie was employed on supplementary work in Kullu, in Sheets Nos. 329 and 331, and also in the Hoshiárpur district in Sheet No. 267.

159. The outturn of the field season's work was as follows :—

	Square miles.
Detail survey on 1-inch scale in Kullu district . . .	487·5
„ „ „ 2-inch „ in Hoshiárpur and Kángra districts	950·7
„ „ „ 4-inch „ in Kullu district . . .	59·1

Of the total area surveyed on the 1-inch scale in Kullu 376·3 square miles were forest lands. In addition 49·8 square miles of forest on the 4-inch scale, and 0·25 square miles on the 8-inch scale, comprised in 65 blocks, were surveyed.

The cost-rate of each description of work per square mile is as follows :—

	R
Detail survey on 8-inch scale . . . . . }	78
„ „ „ 4-inch „ . . . . . }	
„ „ „ 2-inch „	60
„ „ „ 1-inch „	25

160. Considerable progress was made with the fair mapping; 25 sheets, of which 16 were on the 2-inch scale, were sent for publication during the year; 16 are in an advanced state at present; 29 proofs were examined, and 29 were coloured; whilst 25 traces of forest classification were prepared and sent for publication. In addition, a considerable amount of miscellaneous work, such as the preparation of traces of forest areas or boundaries, etc., was carried out by the section.

161. Sepoy Manna Singh completed his two years' course early in October 1900, and only one soldier surveyor, Lance Naik Zarin Shah, 6th Punjab Infantry, has been attached to the party during the year under report.

162. *Simla survey.*—During the winter months out-door work on the Simla survey was discontinued pending the completion of the demarcation of estate boundaries and fixing of boundary pillars, the setting up and plotting of traverses being continued in the office. Early in April work was re-started by four sub-surveyors, two more being sent from the Punjab Detachment in June to hasten the completion of the survey in compliance with the orders of the Punjab Government; during the rains four sub-surveyors were employed in plotting, while the remaining two took advantage of occasional breaks to do revision work. Since June two of No. 18 Party's sub-surveyors have been employed in plotting, and in July a second computer was attached from the Punjab Detachment.

The year's outturn consists of one main-traverse, eleven sub-traverses, and 135 estate boundaries, giving a total of 1,220 stations fixed.

The detail of 15 main-traverses and 33 sub-traverses has been plotted.

In addition to the above some further triangulation was found necessary in order to provide check points about a mile apart along the outer boundary and main traverses.

163. *Programme.*—As mentioned in last year's report, this party, having completed its original programme, will take up work in the plains of the Punjab, and its programme for next season is as follows :—

(1) The traversing of village boundaries in the Pákpattan *tahsil* of the Montgomery district, in continuation of the work carried on there last field season by the Punjab Traverse Detachment.

(2) The examination and correction in the field of the standard sheets on the 2-inch scale sheets compiled from the *patwaris'* maps which have been reduced from the 24-inch scale. This work will be carried out over an area of some 2,400 square miles in the Dipálpur *tahsil* of Montgomery and the Chunián *tahsil* of Lahore district. In the former case the reduced village plots have been fitted on to the traverses carried out by the Punjab Detachment, and in the latter the traverse stations of the old No. 1 Punjab Party have been plotted and used as the basis of the maps. In both cases the reduced plots from the *patwaris'* maps were found to fit in very well with the traverse stations.

(3) Riverain survey for fixing the boundary in the Sutlej river between the Ferozepore, Montgomery and Lahore districts, and further to the south-west in the same river between the Mooltan district and Bahâwalpur State.

(4) Two sub-surveyors will complete on the 1-inch and 2-inch scales the topographical survey of the Native States of Jubbal and Tarhoch and endeavour to fill in all gaps in Sheets Nos. 333 and 334, which are not to be surveyed by the Forest Survey Department.

FOREST SURVEYS.

MADRAS PRESIDENCY.

NOS. 9 AND 19 PARTIES.

164. Mr Hugh Todd held charge of the parties throughout the season under report. On the completion of the recess duties, as far as practicable, the first camp or detachment left Bangalore for the field on the 26th October 1900, the three others leaving soon after; of these, three detachments, after a full six months field season returned to recess quarters between the 5th and 15th of May, whereas the fourth, in its endeavours to complete the work required in the Coimbatore district, did not return till the middle of June.

165. The parties were divided into four camps as follows:—

(1) Mr. H. S. Wilson with 18 surveyors and apprentices, Kurnool district (N. circle).
(2) „ G. T. Hall „ 19 do. Cuddapah „ (C. „).
(3) „ G. D. Cusson „ 10 do. S. Canara „ (S. „).
(4) „ M. J. Sheehan „ 11 do. Coimbatore „ (S. „).

(3) and (4) were formed from the double camp that had been employed during the two previous seasons in the Coimbatore district.

166. In the Nallamalais of the Kurnool district 300 square miles of triangulation were completed, in very difficult ground, consisting for the most part of densely forest clad plateaus. In the Cuddapah and South Canara districts 530 and 505 square miles respectively were completed. This class of work was carried out entirely by native agency, and the results by two out of the three men show a marked improvement on those of the previous season.

167. Theodolite traversing of forest reserve boundaries was carried on in the Kurnool, Cuddapah, and South Canara districts, and a total of 771 linear miles completed, more than double that of the previous season.

168. The area topographically surveyed on the 4-inch scale in the Kurnool, Cuddapah, South Canara and Coimbatore districts amounts to 1378 square miles, or about 78 square miles in excess of the original programme. Special precautions were taken to ensure accuracy, and prevent the surveyors from sacrificing it for quantity, and the work was submitted to a stricter scrutiny than usual, a proportion of the work in each district was examined by the officer in charge in the field, and his instructions to camp officers, to increase their test lines, were duly carried out. The importance of this was fully shown, as the work of several men, amounting in all to about 100 square miles, was rejected.

169. The country surveyed presented similar difficulties, from a surveyor's point of view, to that of previous seasons. In South Canara the evergreen undergrowth, interspersed with the wide spreading and formidable cane, in many places impenetrable, and overtopped by trees of unusual height covering the slopes of the Western Ghâts, contributed towards the difficulties of the surveyor and rendered work tedious and slow.

170. The health of the party was bad. On reaching his ground and before he had time to commence work, one surveyor was attacked by fever and died whilst on leave under medical treatment. He was a very capable hand and his death is a loss to the parties. The unusual rains in February rendered the Moyár valley, at the foot of the Nilgiris very unhealthy, and here three surveyors were almost completely incapacitated by fever. A most distressing catastrophe by fire occurred in the Nallamalais in Kurnool, by which a surveyor was severely burnt and incapacitated for some time, while five out of six of the

khalasis at work with him lost their lives. The officer in charge was attacked by cholera in the Nallamalais, but soon recovered. On the return of the parties to Bangalore there was an unexpected outburst of malarial fever, principally confined to natives, though some of the assistants also suffered for a time, and in some cases men had to be sent on leave for periods ranging from one to six months.

171. During the recess the triangulation and traverse computations were completed, as far as practicable. The fair mapping of the area topographically surveyed, comprising 57 sheets, exclusive of 7 sheets partially mapped last year, was carried out; which, considering the prevalence of sickness, reflects credit on all concerned.

172. In the Cuddapah district the incorrect demarcation of forest boundaries necessitating revision of a considerable area, practically involves the withholding of the season's work from publication.

Until the question of demarcation of the boundary between Mysore and South Canara is settled, the sheets of the South Canara forest reserves must also be held over.

173. The actual cost, including cost of instruments, for the survey year ending 31st August 1901 is R93,335 or R15,845 less than the year previous. The following table shows the comparative cost-rates and area surveyed for the last three years, but the cost-rates are somewhat misleading as they depend greatly on the pay of the senior officers, and, whereas last year two Imperial Officers were with the party as well as the present officer in charge, during the current year the pay of no Imperial Officer at all has been debited to it.

Description of work.	Area Surveyed.			Cost-rates per square mile.		
	1898-1899.	1899-1900.	1900-1901.	1898-1899.	1899-1900.	1900-1901.
Triangulation .	950	1,429	1,335	14	8	6
Traversing . .	598(*a*)	312(*a*)	771(*a*)	15	27(*b*)	8(*b*)
Topography .	1,350	1,524·8	1,378	76	58	58

(*a*) Linear miles. (*b*) Per linear mile.

174. The programme for the ensuing field season comprises continuation of triangulation, traversing of boundaries and topography, in the districts of Kurnool, Cuddapah and South Canara; a more thorough examination of the topography in North Coimbatore surveyed during season 1899-1900; where owing to the camp officer, responsible for the work, having been incapacitated by sickness, it has since been considered advisable to depute an officer to re-examine it before publication; the completion of about 6 square miles of topography remaining in North Coimbatore; the triangulation and traversing of the Godávari river, to furnish the preliminary data for 16-inch survey, and subsequently to commence triangulation of the Upper Godávari forest reserves; topography and traversing on the 4-inch scale of about 40 square miles of the Sivagiri forests, Tinnevelly district.

175. The parties were inspected by Major Longe, Officiating Deputy Surveyor-General, in September. The District Forest Officers of Kurnool, Cuddapah, South Canara and Coimbatore visited the office at Bangalore during recess to carry out the verification of the season's field work with the aid of the Government notifications.

BOMBAY PRESIDENCY.

No. 17 Party.

176. Mr. S. F. Norman held charge of the party throughout the year. Mr. P. R. Anderson joined since last report was submitted. Early in the year the party suffered a serious loss by the death from plague of Sub-Surveyor N. R. Patwardhan, whose services were extremely valuable as an efficient triangulator.

177. The various detachments left Poona for the field during the third week in November, and returned to recess quarters early in June, giving a full working season of six months.

178. The party was divided into three camps under Messrs. C. A. Norman, S. F. Norman and C. J. Veale, respectively, and continued the survey, on various scales, of the Forest areas in the Northern, Central and Southern Circles of the Bombay Presidency; these operations comprising:—

(1) *Northern Circle*—

(*a*) Supplementary triangulation in the Murbád *táluka* of the Thána district.

(*b*) Detail survey on 8-inch scale of the teak reserves in the Dáhánu *táluka*, Thána district.

(2) *Central Circle*—

(*a*) Supplementary triangulation in the Málegaon, Báglán and Peint *tálukas* of Násik district.

(*b*) Detail survey on 8-inch scale of the teak reserves in the Dindori and Kalvan *tálukas* of the Násik district.

(*c*) Supplementary triangulation in the Málsiras and Bársi *tálukas*, Sholápur district.

(*d*) Detail survey on the 4-inch, 8-inch and 16-inch scales in the Málsiras, Sángola, Sholápur, Mádha and Bársi *tálukas* of the Sholápur district. The 16-inch scale being confined to *Babul* Reserves below flood level, in accordance with recent orders of the Government of Bombay.

(3) *Southern Circle*—

(*a*) Supplementary triangulation and traversing in the Khánápur, Belgaum and Sampgaon *tálukas* of the Belgaum district.

(*b*) Detail survey on 4-inch scale of North Kánara District (Honávar *táluka*) and of part of the Khánápur *táluka* of the Belgaum district.

(*c*) Detail survey on 8-inch scale in the Mahád *táluka* of the Kolába district.

179. The following table shows in detail the outturn with cost-rates for the year under report and the two previous years:—

Description of survey.	Outturn.			Cost-rates		
	1898-99.	1899-1900.	1900-01.	1898-99.	1899-1900.	1900-01.
				₹	₹	₹
Triangulation (stations) . .	230	256	365	18·3	23·2	12·5
Traversing (linear miles) .	166	191	315	10·9	8·2	7·1
Topography 4-inch (sq. miles) .	429	379	409·7	53·2	64·1	65·4
„ 8 „ . .	254	236	254·8	136·6	139·5	106·7
„ 16 „ . .	55	55	10·8	122·9	134·1	113·0

The cost-rates are satisfactory and show a decrease, except in the case of the 4-inch detail survey, which is attributable to the scattered nature of the work on that scale.

180. The work was thoroughly examined and tested while in progress by the officer in charge and the camp officers.

181. During the recess, most of the mapping of the past season's work has been completed.

A small Drawing Office was left in Poona during the field season to bring up the arrears of mapping, with Govind Gopal, a senior surveyor, in charge; this small detachment will have to be retained in future, as it is quite impossible for the recess staff to cope with the large amount of mapping which has yearly to be disposed of.

182. The programme for 1901-1902 is in continuation of that for the past season.

183. The party was inspected during September by the Surveyor-General.

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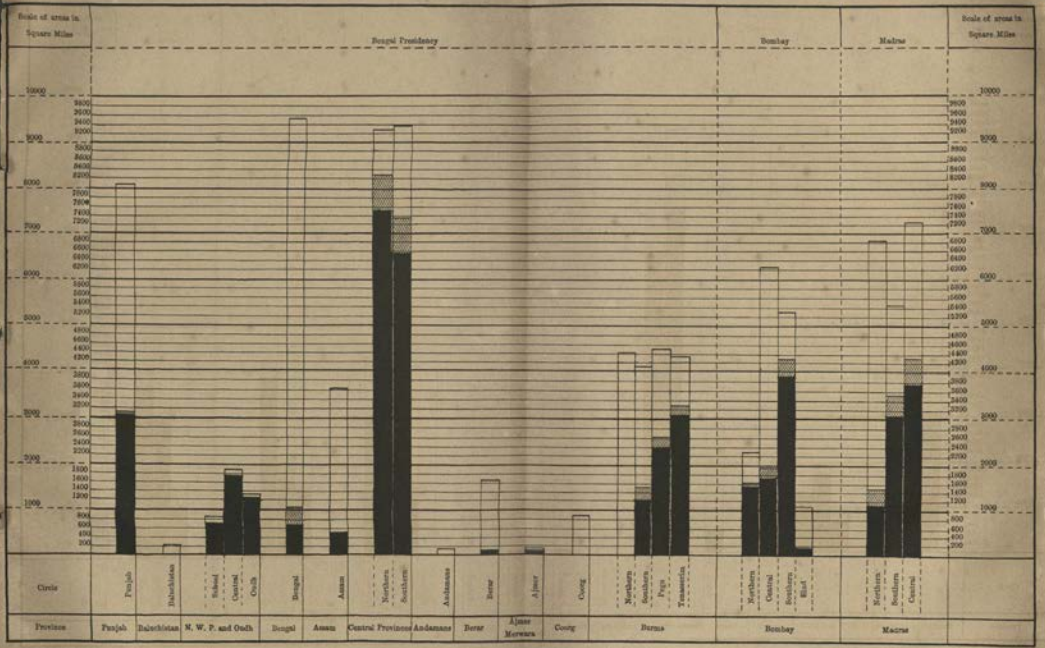
DIAGRAM SHOWING PROGRESS OF FOREST SURVEYS ON 4" = 1 MILE AND ON LARGER SCALES UP TO 30th. SEPTEMBER 1901.



Note.—This diagram does not take into account any enclosed forests or C-class forests in Berar.
The areas surveyed do not include boundary surveys.

Unsurveyed forest area.....
Surveyed during the year.....
Surveyed previously.....

Photo. S. I. O., Calcutta.

No. 465-S. 02.

OPERATIONS OF THE FOREST SURVEY BRANCH.

184. Major P. J. Gordon, I.S.C., held administrative charge as Superintendent, Forest Surveys, Bengal Presidency, under orders of the Inspector General of Forests and the professional control of the Surveyor-General.

185. Revised orders for the adjustment of expenditure on Forest Surveys have been issued by the Government of India during the year; these provide that the cost of all Forest Surveys on a scale of not less than 4 inches to 1 mile, in Bengal, the North-West Provinces and Oudh, the Punjab, the Central Provinces, and Burma, shall in future be uniformly distributed in the proportion of 30 per cent. to topographical surveys in consideration of the topographical value of the work, and 70 per cent. to Forests. The cost of surveys executed by local Forest Officers and of special large scale surveys will, as heretofore, be borne by the Forest Department.

186. The following brief statement will indicate the nature of the year's operations, of which full details are being published separately in the annual Progress Report of the Superintendent, Forest Surveys, Bengal Presidency.

187. No. 20 Party, Survey of India, under the charge of Mr. T. E. M. Claudius, was divided into 6 detachments working in Burma; while the remainder of the Forest Surveys Branch consisted of 9 detachments working in the Central Provinces, Bengal, and the Punjab; the whole outturn being as follows:—

Province and Forest Division.	Outturn.				Number of Surveyors.
	4-inch Detail Survey.	Triangulation.	Traversing.	16-inch Boundary survey.	
Burma.	sq. m.	sq. m.	sq. m.	linear. m.	
Upper Chindwin	...	290	67	...	59
Ruby Mines	318	214	427	...	
Pyinmana	44	...	40	...	
Minbu	...	...	166	...	
Rangoon	9	...	...	...	
Pegu	124	...	130	...	
Thayetmyo	86	...	214	...	
West Salween	3	...	23	...	
Ataran	289	...	146	...	
South Tenasserim	...	30	25	...	
Central Provinces.					
Mandla	774	404	105	951	48
Damoh	6	...	...	...	1
Chánda	776	293	76	740	39
Bengal.					
Singhbhum	361	650	128	...	35
Punjab.					
Hazára	...	In progress	...	...	2
Jubbal and Tarhoch	43	...	...	...	5
Total	2,833	1,881	1,547	1,691	189

In addition to the above, one surveyor was deputed to Ajmer to work under the local Forest Officer, and three others to assist the Forest Officer of Kheri in Oudh; also a large amount of miscellaneous mapping and publication for various provinces was carried on at the head-quarters offices at Dehra Dún.

188. It may be noted that the small States of Jubbal and Tarhoch provided funds for a 4-inch detail survey of their forests, and it is hoped that other native

States having valuable forest reserves will avail themselves of the agency of the Forest Survey Branch to have accurate surveys made of their reserves, in order to ensure economic exploitation.

189. The Forest Surveys have generally in the past been able to make use of a certain amount of triangulation and traversing previously carried out by parties of the Survey of India, so that they have only a small staff capable of conducting this part of the work; it is feared that this want of triangulators may occasion some difficulty in the near future, now that the forest surveys are beginning to open up ground not previously surveyed, and it will be a few years before a sufficient number of men can be trained to these duties.

190. The accompanying diagram shows in a graphic manner the general progress of forest surveys throughout India. Of the balances unsurveyed, the survey of a large proportion of those shown in Bengal, Assam and Berar is not contemplated at present, and for the greater part of the balance in the Punjab boundary surveys only are required.

191. The strength of No. 20 Party has been greatly increased within the last two years, and its present total of some 60 surveyors is the maximum over which one officer can be expected to carry on even a general supervision; in spite of the efforts of the officer in charge, it became evident that the *locale* of operations was far too extended and scattered during the year under report.

In future arrangements will be made to confine the operations of this party as much as possible to the Chindwin and Lower Irrawaddy basins, and to employ separate forest survey detachments on the more scattered reserves of Burma. Mr. Claudius is now retiring after a service of 38 years in the Survey of India Department, and Captain Hume, R.E., succeeds him in charge of the party.

192. The programme sanctioned by the Inspector-General of Forests for the ensuing year is as follows:—

Burma.—In Upper Chindwin and Myittha Divisions, triangulation, traversing, and detail survey.

In Minbu Division, traversing and 4-inch detail survey to complete the Taungdwingyi block.

In Mandalay Division, traversing.

In the Ruby Mines Division, traversing and 4-inch detail survey.

In Ataran Division, a small amount of 4-inch detail survey to complete the *Ye* reserve.

Central Provinces.—In Mandla and Chánda Divisions, 4-inch detail and 16-inch boundary surveys, which will practically complete the surveys of the Northern and Southern Circles.

Bengal.—In Singhbhum Division to complete the 4-inch detail survey of reserved forests; other work in this division is contingent on the settlement being sanctioned.

In Hazáribágh Division, 4-inch detail survey of Koderma and adjoining protected forests, to show position of mica mines.

In Kurseong Division, a 4-inch boundary traverse will be undertaken if the settlement in the Singhbhum Division is not sanctioned.

North-West Provinces and Oudh.—In the Gorakhpur, Kheri and Pilibhít Divisions, a 4-inch boundary survey to complete all the surveys in these divisions.

Punjab.—In Jubbal and Tarhoch, 4-inch detail survey to complete the past year's work.

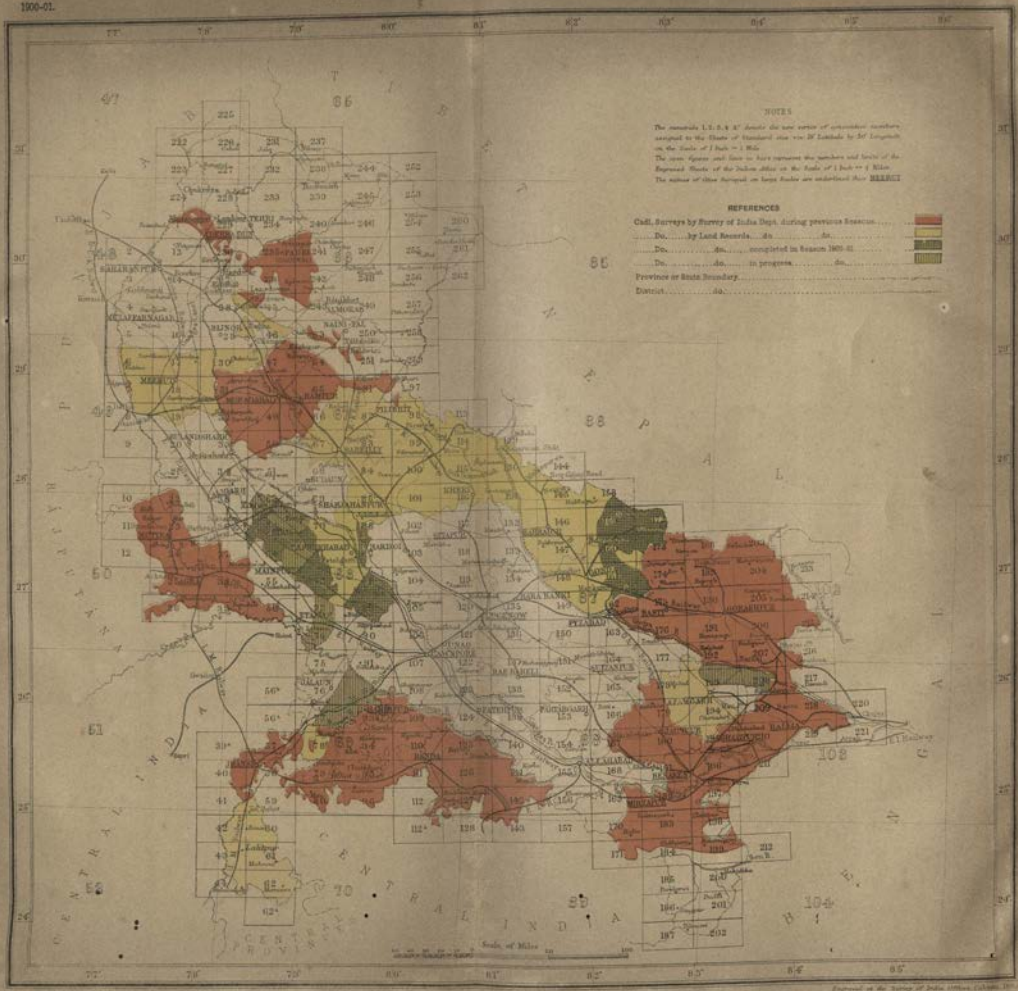
In Hazára Division, 4-inch boundary survey to complete existing maps.

Ajmer.—Four-inch detail survey under the local forest officer.

N. W. P. & OUDH SURVEY.

INDEX TO THE CADASTRAL SURVEY IN THE N. W. P. & OUDH.

1900-01.



Engraved at the Survey of India Offices, Calcutta, 1901.

No. 594-S. 01. Photo. S. I. O., Calcutta.

N. W. P. & OUDH SURVEY.

1900-01

INDEX TO THE TRAVERSE SURVEY IN THE N. W. P. & OUDH.

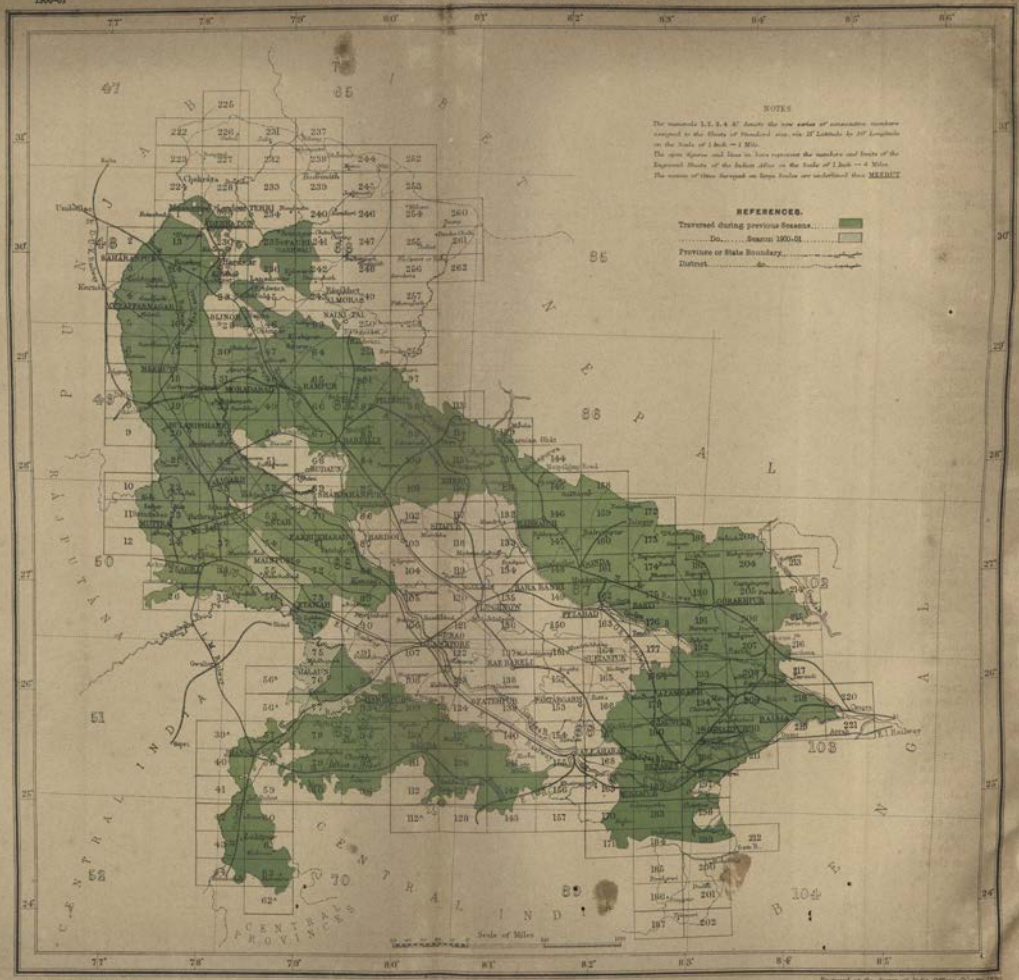


Photo. S. I. O., Calcutta.

No. 642-S. Ol.

CADASTRAL SURVEYS.

NORTH-WESTERN PROVINCES AND OUDH.

NOS. 2 AND 8 PARTIES.

193. The Provincial surveys in the North-Western Provinces and Oudh remained under the charge of Mr. G. B. Scott up to the date of that officer's retirement on 31st July, when his successor, Captain W. M. Coldstream, R.E., took over charge.

194. The work has been carried out by three sections, namely, the Traverse, Drawing, and Cadastral Sections, the last consisting of seven cadastral parties and one detachment.

195. *Traverse Section.*—The Traverse Section completed the traverse survey of districts Azamgarh, Farrukhabad, Mainpuri, Etáwah, and Jálaun, and the scattered areas in Aligarh where cadastral survey is required, and continued the traverse of the Etah district.

With the exception of a small area remaining in Etah, the above completes the programme of traverse survey at present required for revenue purposes in these Provinces, and in consequence the Traverse Section will be withdrawn from provincial employment and attached to No. 14 Party for the traverse for topographical purposes of the Allahabad district, a small detachment being detained for the completion of the remaning work in Etah.

In order to obviate the necessity of further traverse, at a later date, in Allahabad, it has been decided to traverse that district on the village circuit system, which will provide a sufficient number of points for the revision of the village maps, or for a re-survey, should one be considered necessary, provided that the survey stations are carefully maintained, and this, it is hoped, will be secured by the regulations requiring each *patwari* to report annually on the condition of the survey stations in his circle.

196. The average number of survey stations laid down during the year was 15·4 per square mile; of these 10 per cent. were fixed on village-trijunctions previously marked by the district authorities, 35 per cent. were marked by roughly dressed stones, and the remaining 55 per cent. by baked clay cylinders embedded at the site.

The cost of survey marks of both descriptions laid down by the Traverse Section came to ₹3.3 per square mile.

197. The quality of the work was checked by comparison with the values of eight stations of the Great Trigonometrical Survey, the linear errors so disclosed being from 0·49 to 10·2 feet per mile. The angular accuracy of the traverses was ensured by one observation for azimuth to the sun or stars in an average of 32 angles; the angular errors so found varying from 1 minute in 10 angles on village circuits, to 1 minute in 27 angles on main circuits.

198. The total area traversed during the year under report was 2,615 square miles, and the total expenditure of the Traverse Section was ₹69,538 which gives a cost-rate of ₹27 per square mile, those of the three preceding years being ₹27, ₹29, and ₹26.

199. All computations have been completed, and plotted sheets of the area traversed have been made over to the cadastral parties, except those of Etáwah, where cadastral survey has been postponed for some years.

200. *Drawing Section.*—The drawing section is located at Naini Tal under Mr. J. Kennedy.

Of the six districts completely surveyed by the Provincial Surveys the map drawing of two, Sháhjahánpur and Bareilly, has been completed, except as regards the town and cantonments of Bareilly which are now under survey; the mapping of three districts Bahraich, Pilibhít, and Kheri is in progress; and that of Lalitpur sub-division in Jhánsi is completed.

The topographical maps of one district, Meerut, being comparatively modern, the preparation of new maps is postponed, pending a comparison of the existing maps with the new cadastral survey. As pointed out in last year's report, every effort is being made to include in the cadastral survey all topographical features on the ground.

The total cost of the Drawing Office for the year has been ₹10,651.

201. *The Cadastral Section.*—During the year, the survey and *khasra*-writing has been completed in Gonda, Farrukhabad, and in the scattered areas of Aligarh which were included in the programme.

One cadastral party has worked in each of the following districts: Azamgarh, Mainpuri, Farrukhabad, Etah, and Jálaun; two parties have worked in Gonda, and a detachment in Aligarh. The survey of Etáwah having been postponed by the Board of Revenue, the party working last year in that district was transferred to Jálaun.

The two Gonda parties having completed their programme are to come under reduction, and the Farrukhabad party is to be transferred to Jálaun to work as a second party in that district. The Aligarh detachment is to take up the revision of existing maps in the Jalesar *tahsil* of Etah, where the existing village maps are in comparatively good condition.

As a result of the reduction of the Gonda parties, two officers, Messrs. Bedford and Skilling, will revert to Imperial employment on the completion of the settlement records of Gonda in November, while Mr. Norman (Jr.) has already reverted.

202. The number of *patwaris* in the tracts under survey was 1,529, of whom 1,129 qualified as surveyors, 64 are yet to be examined, 185 deputed their heirs to do the survey, and substitutes were provided for 113 who failed to qualify.

In addition to the *patwaris* it was found necessary to employ *amins* for longer or shorter periods in the alluvial tracts of Azamgarh and Farrukhabad, and in the scattered areas of Aligarh. The *khasra*-writing was, however, done entirely by the *patwaris* or their heirs. The average outturn in survey varied from 4 acres to 26 acres, and in *khasra*-writing from 5 numbers to 45 numbers per man per diem.

203. All maps before being passed were checked by European officers or by *partallers* working directly under the Survey officers.

The average linear amount of check lines per square mile was 4·7 miles.

Twenty-one per cent of the *khasra* numbers were also checked.

204. The total area cadastrally surveyed during the year was 3,944 square miles, and the total expenditure in the survey parties has been ₹2,56,906, the cost-rate being ₹75 per square mile for survey and record-writing.

The cost-rates for next year are likely to be considerably higher owing to the fact that, as the work is drawing to a close, the areas for survey are small in several districts while the full office establishment is required to deal with the records of the past and coming seasons.

205. In addition to the regular programme of work for revenue purposes, town surveys on the 64-inch scale have been undertaken in Cawnpore, Fyzabad, Ajodhya, and Mainpuri, under the supervision of the district Survey officers.

The expenditure in connection with these surveys has been met by the Municipalities concerned. Surveys of Government roads in Mainpuri, Etáwah, Farrukhabad, and Jálaun have also been undertaken at the expense of the Public Works Department and of the Local Boards, under the supervision of the Traverse Section.

206. During the field season Mr. G. B. Scott inspected all the parties in the field, personally instructed a class of 15 young officers of the civil service in the rudiments of survey, and surveyed a portion of the Kheri-Bahraich boundary, and in the rainy season in company with the Deputy Superintendent inspected the offices of the cadastral parties in Aligarh, Etah, Farrukhabad, and Jálaun. Mr. Scott handed over charge of his duties to Captain Coldstream at Jálaun on the 30th of July on his retirement from Government service.

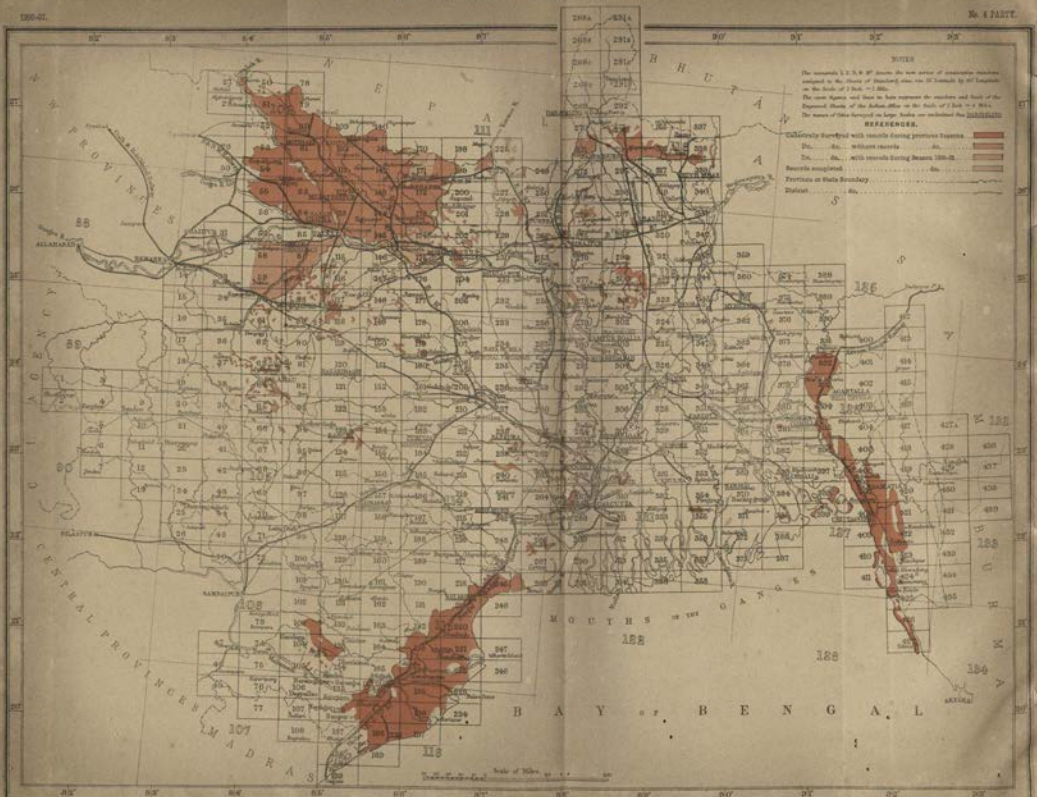
207. Captain Coldstream as Deputy Superintendent took over charge of the cadastral party working in Mainpuri in November, and remained at Mainpuri up to the 30th of June 1901, in order to gain a further insight into the methods of record and survey work in these provinces. In the rainy season Captain Coldstream inspected the offices of the parties in Aligarh, Etah, Fatehgarh, Jálaun, Gonda, and Azamgarh and checked the town surveys in Cawnpore and Fyzabad.

208. The field parties were visited and inspected by Col. Hobday, Deputy Surveyor-General, in January, and by Major Longe, officiating Deputy Surveyor General in April and May. Major Longe also inspected the Traverse and Drawing offices at Naini Tal in September.

BENGAL SURVEY.

INDEX TO THE CADASTRAL SURVEYS IN BENGAL.

1900-01. No. 4 PART V.



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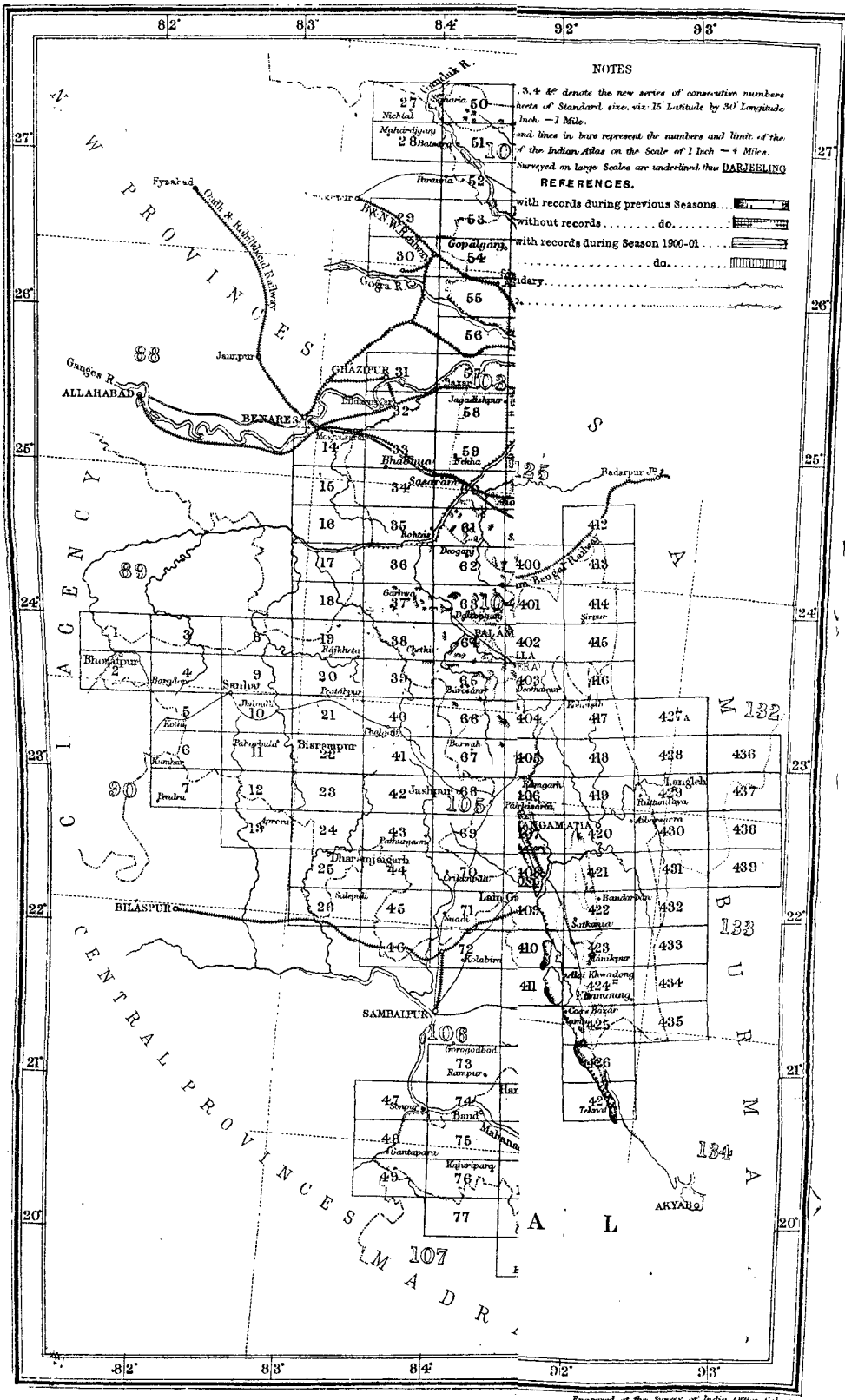

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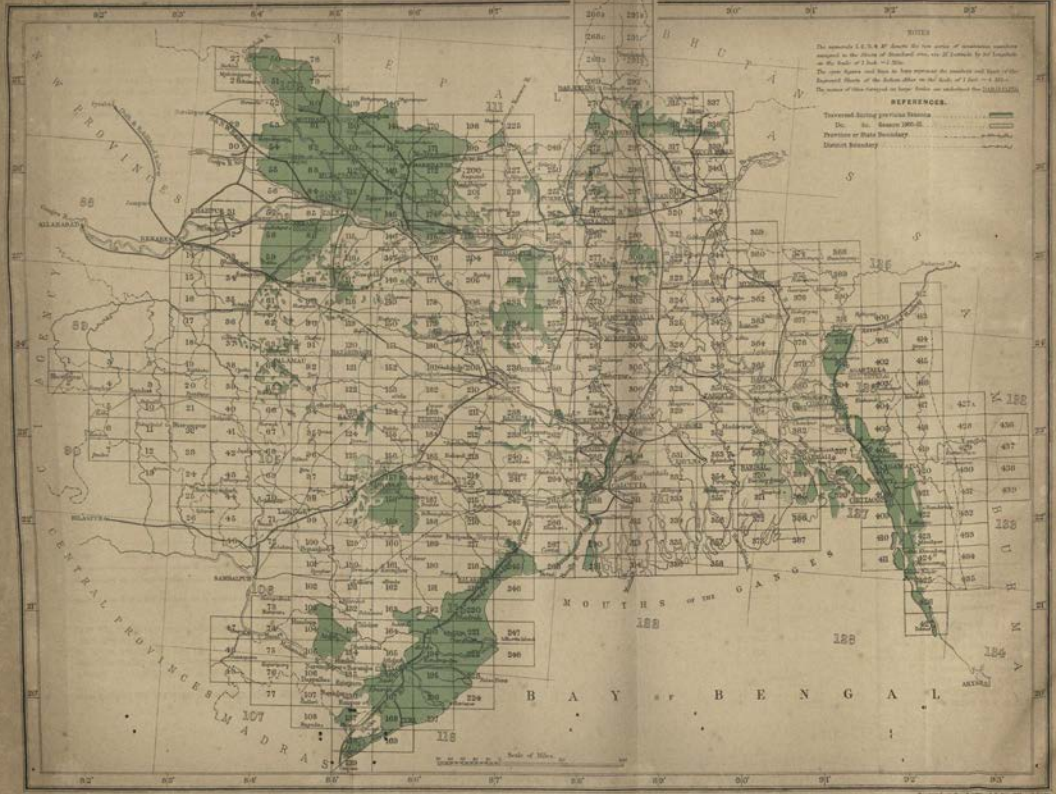
BENGAL SURVEY.

INDEX TO THE TRAVERSE SURVEY IN BENGAL.

1900-01. No. 4 PARTY.



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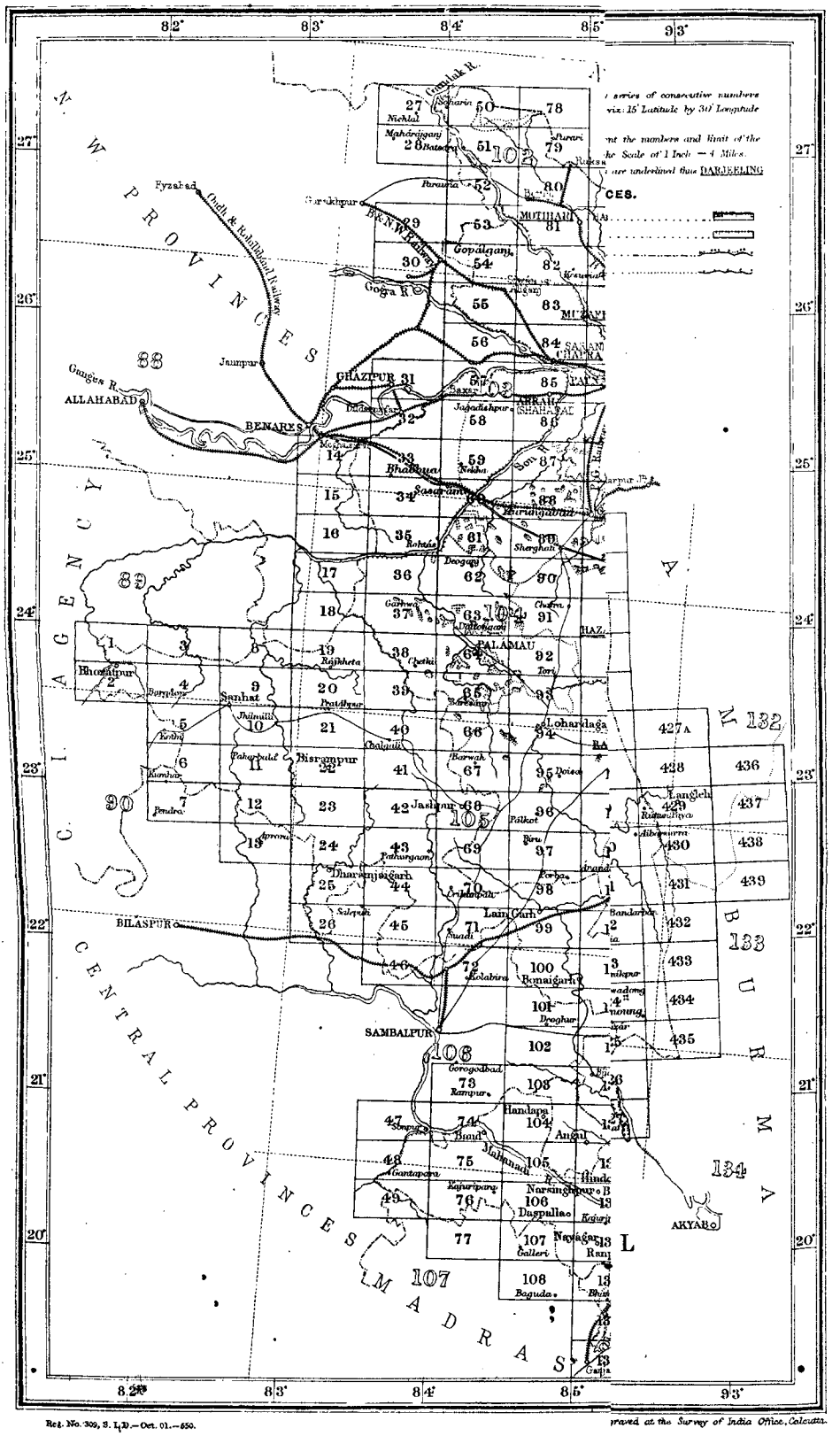
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C. I. AGENCY
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BURMA
Fyzabad
Oudh & Rohilkhand Railway
Gorakhpur
B.N.W. Railway
Gogra R.
Ganges R.
ALLAHABAD
Jaunpur
GHAZIPUR
BENARES
Chanduk R.
Nichlul
Maharajganj
Bhatauli
Puraina
Gopalganj
MOTIHARI
CHAPRA
SARAN
SHAHABAD
Jagadishpur
Bhalhua
Nekha
Son R.
Rohtas
Sherghati
Deogaon
Gaighat
Chatra
PALAMAU
Rajbheta
Tori
Bhagalpur
Sanhat
Pratapur
Jhilmilli
Kerba
Pahar pulal
Bisrampur
Kumhar
Pendra
Jashpur
Palkot
Pahargaon
Dharamjaigarh
Lailunga
Sundi
Kolabira
Bamaigarh
Deogbar
SAMBALPUR
Gorogodbad
Rampur
Handapa
Bund
Angul
Jharmundi
Kantapara
Rajnandgaon
Narsinghpur
Dagpullia
Galleri
Baguda
Nayagarh
AKYAB
Lohardaga
Ranchi
Bhandaria
Purari
Motihari
Gopalganj
Chapra
Jagadishpur
Arrah
Shahabad
Sasaram
Bhabua
Nokha
Rohtas
Sherghati
Deogaon
Gaighat
Chatra
Palamau
Rajbheta
Tori
Bhagalpur
Sanhat
Pratapur
Jhilmilli
Kerba
Pahar pulal
Bisrampur
Kumhar
Pendra
Jashpur
Palkot
Pahargaon
Dharamjaigarh
Lailunga
Sundi
Kolabira
Bamaigarh
Deogbar
Sambalpur
Gorogodbad
Rampur
Handapa
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Angul
Jharmundi
Kantapara
Rajnandgaon
Narsinghpur
Dagpullia
Galleri
Baguda
Nayagarh
Akyab

BENGAL SURVEYS.

No. 4 Party.

209. The Cadastral Surveys in Bengal were continued under the superintendence of Captain Crichton, I.S.C.; Major Hodgson and Captain Mears each officiated as Superintendent for a few days until his return from furlough on the 6th November.

210. During the year the title of the office was changed to Superintendent, Provincial Surveys, Bengal.

211. The following table gives the outturn of work for the year in square miles :—

Division.	District and estate.	Traverse survey.	Cadastral survey.	Record-writing.	Topographical survey.
1	2	3	4	5	6
Temporarily-settled and Government Estates.					
Major settlements.					
Bhágalpur . . .	Sonthal Parganas (Dáman-i-koh Government estate).	735(*a*)	...	...	...
Private Estates.					
Major settlements.					
Bhágalpur . . .	Monghyr	747	741	720	26
Patna . . .	Patna	60	56	56	11
	Darbhanga . . .	64(*b*)	413	597(*c*)	...
Bhágalpur . . .	Purnea	728	...	...	...
Patna	Gaya (Maksúdpur estate) .	128	...	...	...
Dacca	Backergunge . . .	608	33	33	...
Chota Nágpur . .	Singhbhum (Poráhát, Kera, Chainpur, and Bandgaon Estates).	540	...	...	...
Miscellaneous.					
Patna . . .	Champáran . . .	84	...	...	84
	Darbhanga (Madhubani Municipality).	1	1	1	...
Rájsháhi . . .	Jalpáiguri (Baikuntpur estate boundary survey).	...(*d*)	...	...	...
	Total .	3,695	1,244	1,416	121

(*a*) Includes 166 square miles of jungle blocks and Paharia villages, also 2 square miles surveyed in the area returned as jungle blocks last season.
(*b*) Retraversing to relay stations of 1895 lost.
(*c*) The excess of record-writing over survey is on account of completion of the area surveyed only during previous season.
(*d*) Traversing of 97 linear miles for demarcation purposes.

In Monghyr, Patna and the Sonthal Parganas the areas traversed are respectively 147, 60 and 35 square miles in excess of the original programme. While in the two first named districts an excess of 191 and 56 square miles of cadastral work was also accomplished; in Darbhanga the area cadastrally surveyed also shows an excess of 31 square miles and in Backergunge 33 square miles over the anticipated area.

In Bhágalpur, Patna and Chota Nágpur the areas traversed are slightly less than was expected.

212. The following table showing the cost-rates per square mile of the various classes of work, and the explanatory notes have been abstracted from the published Annual Report on the survey operations in Bengal for 1900-1901 :—

District.	Cost-rate per square mile.			
	Traverse.	Cadastral.	Record-writing.	Topographical survey.
1	2	3	4	5
	₹	₹	₹	₹
Sonthal Parganas	55·4	...	...	...
Monghyr and Patna	29·4	70·9	58·2	16 0
Darbhanga	...	94·0	95·2	...
Purnea	38·4	...	...	...
Gaya-Maksúdpur estate	39·8	...	...	...
Backergunge	75·2	...	...	...
Singhbhum	55·9	...	...	...
Champáran	46·2	...	...	61·3

The cost-rate for traversing in the Sonthal Parganas, *viz.*, ₹55·4 per square mile, is high, but this is due to the very difficult nature of the country in the Dáman-i-koh and to the great amount of sickness amongst the establishment.

The traverse cost-rate of ₹29·4 per square mile for Monghyr and Patna is satisfactory, and is due to the large area accomplished by the North Bihar traverse section and the consequent low incidence of cost of control per square mile. The rate of ₹129·1 per square mile for cadastral survey and records in Monghyr and Patna is satisfactory, and compares well with the cost-rates of previous season's work in Bihar. The low rate is attributable to the large area accomplished, *viz.*, 797 square miles, and to the larger size of the average field, *viz.*, 0·59 of an acre. The cost-rate for topographical survey is also good. The work was very simple and amounted to practically only a boundary survey with few details.

213. The cost rate for Darbhanga of ₹189·2 per square mile for cadastral survey and records is high. The rate of ₹94 for cadastral survey, however, includes the bringing up to date of 186 square miles surveyed during the previous season but not *khanapuried*, and another reason for this high rate is the restricted programme, as only 413 square miles remained to complete the Darbhanga district. The high rate for record-writing, as compared with Monghyr work, is accounted for by the much smaller fields (only 0·35 of an acre) of Darbhanga. The outturn was also only 597 square miles as compared with the 785 of Monghyr and Patna. The cost-rate of ₹38·4 for traversing in Purnea is not excessive considering the unhealthiness of the tract surveyed. It should also be remembered that the cost of moving the camp and establishment to Purnea is included in this rate.

214. The rate of ₹39·8 for the Maksúdpur traversing is good considering the very scattered nature of the work and the difficulties experienced and time lost in locating the villages of the estate.

The rate of ₹75·2 for traverse work in Backergunge is very high. This is accounted for by the fact that this is a newly started survey, and therefore, the cost of tents, office furniture, camp equipment and their transit charges as well as transit charges of establishment and instruments, are included in the expenditure. Also a large number of cylinders for marking stations had been ordered in advance from Rániganj. Arrangements have been made for the supply of cylinders locally, and none of the foregoing charges will be recurring in future seasons' work, but we cannot expect the cost rates to be as low as in Bihar, because no local labour is available and all *khalasis* have to be imported and then paid at nearly double the Bihar rates of pay. The nature of the country makes the supply of boats to the surveyors necessary, and this is a heavy item of expenditure. The future cost-rate should be about ₹60 per square mile unless the programme is largely increased.

For the cadastral survey and record-writing in the Bamna Estate of the district, the cost-rates have not been computed, as this was an experimental survey carried out by a very large establishment for the small area, and the resulting cost-rates cannot be any guide for future work.

The cost-rate of R55·9 for Singhbhum traverse work is high. This is due to the difficult nature of the country, excessive sickness amongst the establishment and to the small programme. This section has a full programme in Singhbhum and Ránchi next season, and the rates will be lowered very considerably.

The cost-rates of R46·2 and R61·3 for traverse and topographical surveys in Champáran are reasonably fair considering the difficult nature of the country (which had to be closely contoured), the sickness amongst the establishment and the small programme.

215. The general procedure remained unaltered. The survey establishment carries out the Traverse and Cadastral surveys, and then, under the direct instructions and supervision of the Settlement Department, writes the records.

The entire field establishment, Inspectors and Amins, is retained throughout the year, each man during recess completing the records and statistical statements of the villages surveyed by him.

"DIÁRA" SURVEYS.

216. The experience of the past season has shown that the attempt to traverse villages in *Diára* tracts in accordance with the boundaries shewn on the old revenue survey maps should be abandoned.

The *Diára* survey of 1865 has in the minds of the inhabitants superseded the revenue survey, and in consequence the preliminary demarcation conforms generally to the *Diára* survey, and the Superintendent, Provincial Surveys, has therefore decided to traverse these tracts in accordance with the demarcation found on the ground, serving out to the line-clearers and traversers traces of the *Diára* survey instead of the old revenue survey, to enable them to work where the demarcation is found deficient. Subsequently the usual comparison will be made with the old revenue survey and all differences shewn.

Another difficulty which made itself severely felt was the uncertainty first of the *Diára* area, and secondly how much of that area should be Cadastrally and how much Topographically surveyed. To get over this it is intended to run traverses along the high banks of rivers immediately after the rainy season, these when computed and plotted will give an idea of the area to be dealt with, and within these limits can be allotted all Government and temporarily settled estates for cadastral survey, and the area for topographical survey can then be approximately estimated. There appears to be no reason why these preliminary traverses should not be run a year in advance of the actual survey, as they would be situated on ground beyond the limits of river action.

217. This year village sites in Bihar were surveyed on the 64-inch scale, each hut being separately and accurately surveyed, but as the hut is linked with its *sakin* or homestead land, and consequently only a *kitta* of the survey unit, it has been decided to abolish the survey of huts, except under certain stated conditions, and a considerable saving in expense is anticipated in consequence.

218. The increase in the Traverse programme from 1,379 square miles in 1899-1900 to 3,791 this year, severely strained the resources of the party. Every available traverse surveyor was given employment, and a number of new men were after a short course of instruction sent on field work. The result was that a considerable amount of revision had to be done, and the cadastral operations were several times in danger of coming to a stand-still owing to the traverse work not being available. To avoid this in future the Superintendent has, with the permission of the Board, started a traverse school at Dumka, and about 40 sub-surveyors with the proper proportion of *tindals* are undergoing a course of instruction there, and will if they prove suitable be eventually drafted into the various field parties next field season, the expenses being debited to the parties to whom the men are sent. It is hoped that this will lead to increased efficiency and an immediate reduction in cost-rates.

219. As regards traverse operations the people displayed extreme apathy except in Singhbhum, where help was readily afforded. In Darbhanga the attendance for the cadastral survey and record-writing was satisfactory, but in Monghyr there was much trouble. In Backergunge there was no active opposition, which may be considered satisfactory.

220. There was an unusual amount of sickness during the year. While in Darbhanga and Monghyr the health of the establishments was uniformly good, notwithstanding the prevalence of plague in the latter district; in Purnea, Singhbhum, Champáran, and the Sonthal Parganas, at times as many as 50 per cent. of the men were on the sick list with fever, and the work suffered much in consequence.

221. The Bihar and Singhbhum traverse sections recessed at Mussooree, while the Sonthal Parganas and Backergunge sections remained at the headquarters of their districts; the Darbhanga and Monghyr cadastral sections recessed at Bhágalpur and Dígha (Dinapore) respectively.

222. Seven junior officers of the Indian Civil Service underwent a short course of instruction in Traverse and Cadastral Surveying.

223. The season's work on the Nepál frontier was carefully compared with Colonel Tanner's survey of 1882-83, and with the old revenue survey maps. The surveys agree well, only one stone prism, No. 15, which had been washed away by the Kamla river, was found to have been re-embedded on safe ground, 373 feet west of its original position.

224. The Topographical Survey of the Patna *Diára* area on the 16-inch scale, covered 11 square miles. This area is almost all sand or water, the village sites were surveyed in blocks on the field plans. In Champáran the Topographical survey was based on the traverse stations and points fixed by plane-table intersections by an experienced topographical surveyor. The country was hilly, jungly and very thinly populated and fever was very prevalent.

The whole of the work in the Champáran district is now complete, and the compilation of the standard sheets is being carried on in the Bengal Drawing office.

SONTHAL PARGANAS.

225. The traverse survey detachment in this district was exclusively employed on the completion of the traverse work in the Government estate of Dáman-i-koh. The field season extended from the 18th October 1900 to the 2nd June 1901 and the outturn is 735 square miles, comprising 979 villages and 22 jungle blocks of an aggregate area of 166 square miles.

The preliminary demarcation was satisfactory. Seventeen thousand seven hundred and twenty-three new traverse stations were fixed and marked as follows:—1,969 by stones, 6,582 by clay cylinders and 9,172 by wooden pegs.

The country is hilly and difficult to work in, and the subtense bar method of ascertaining the direct horizontal distance between traverse stations had to be freely resorted to; this method though necessary is laborious, and takes a considerable time longer than chaining, which partly accounts for the lateness of the date on which the programme was completed; but a still greater cause of delay was the wholesale desertion of members of the establishment, chiefly owing to the unhealthiness of the district, and there were nine deaths amongst the men.

The records have been completed except that the co-ordinates of the main and sub-circuits have not been finally closed, pending an attempt which will be made next season to connect up with the Great Trigonometrical Survey on the other side of the Ganges. The angular and linear corrections, however, are well within the percentage allowed.

The magnetic variation as derived from 140 azimuth observations is 1°46′ east of the true meridian.

MONGHYR.

226. The operations consisted of the traversing of the Ganges *Diára* in *thanas* Tegra and Begusarai for immediate detail survey, and of an upland area in *thana* Gogri in advance for next season.

The outturn in the *Diára* tracts covers 198 villages aggregating 246 square miles, and in Gogri 255 villages or 501 square miles. The demarcation in the upland tracts of Gogri was on the whole very satisfactory. That of the *Diára* tract has already been remarked on.

Eleven thousand seven hundred ninty new stations were fixed and of these 726 were marked by stones, 7,892 by cylinders and the remainder 3,172 by pegs.

A line of permanent mark stones has been laid along the southern *high* bank of the Ganges at intervals of half a mile which should prove useful for relaying boundaries in *diára* tracts in the future.

The angular work proved good and the chaining on its own merits satisfactory, but a comparison of direct distances between three Great Trigonometrical Stations as derived from this survey and given by the Trigonometrical survey shows a discrepancy of 15 feet per mile which, though it will not interfere in any way with the value of the plots for cadastral work, is excessive.

MONGHYR.

(CADASTRAL SURVEY.)

227. The following table shows the outturn of cadastral survey and record-writing:—

THANA.	CADASTRAL SURVEY.			RECORD-WRITING.		
	Villages.	Fields.	Square miles.	Villages.	Fields.	Square miles.
1	2	3	4	5	6	7
Tegra	517	281,851	204	517	281,851	204
Begusarai	655	501,126	478	655	501,126	478
Monghyr (Diára tract)	5	7,225	34	5	7,225	34
Lakhisarai (Diára tract)	2	2,841	9	2	2,841	9
Surájgarh (Diára tract)	1	239	4	1	239	4
Gogri (Diára tract)	4	5,916	12	...	...	...
TOTAL	1,184	799,198	741	1,180	793,282	729

228. The cadastral survey is mapped on 1,722 sheets on the 16-inch scale, and for village site surveys on the 64-inch scale, for which there was insufficient room on the margins of the 16-inch sheets, 570 extra sheets have been prepared.

The detail survey was checked by 2,131 linear miles of *partals* run by the Survey officers, and independently, and by 2,134 linear miles of *partals* by Inspectors. This gives a total of 4,265 linear miles and an average of 5·75 linear miles of test survey to each square mile of detail survey. In addition the village sites were tested by resurveys of 435 portions and by 3,581 *partal* lines run through the main streets and alleys.

The demarcation throughout the area surveyed was found to be very imperfect, and in many cases the village boundaries appear to have been unknown to the landlords.

The record-writing, owing to the large number of petty landlords who had to be dealt with, has been very intricate. In the 1,180 villages of the season's outturn, there were 68,237 landlords, 6,011 *tausis* and 9,831 *pattis*.

In a plot of land, area 0·57 of an acre, there are 1,582 shares. Thus each share represents 0·00036 of one acre. Another curious feature in the season's work occurs in the Government estate of Ramdiri, where the fields owned by many co-sharers vary from 25 links to 5 chains in width and are 1¾ miles in length.

229. In Patna a traverse survey of all lands lying between the southern boundary of Monghyr to the North of the Ganges and that part of the southern high bank of the river in the Patna district was completed, and comprised 22 villages in Barh and Mokameh *thanas* of an area of 60 square miles. Three-hundred and fifty-two stations were fixed and of these 48 were marked by stones in continuation of the line of permanent marks referred to in the details of the Monghyr traverse survey, the remaining stations being marked by ten pottery cylinders and 294 pegs.

Of these villages 18 were cadastrally surveyed and mapped on 71 sheets, and four with an area of 11 square miles were topographically surveyed on the 16-inch scale and mapped on 10 sheets.

DARBHANGA.

230. In Darbhanga the traversing had been completed in 1899 but as that of the area under survey was done in 1895-96 it was feared many of the theodolite stations would have disappeared. As a matter of fact, the theodolite was set up at 1,289 stations only, and this revision was confined to an area of 64 square miles in *thana* Madhubani and necessitated the rechaining of 177 linear miles.

CADASTRAL SURVEY.

231. The following table gives the outturn for the season.

THANA.	CADASTRAL SURVEY.			RECORD-WRITING.		
	Villages.	Fields.	Square miles.	Villages.	Fields.	Square miles.
1	2	3	4	5	6	7
Madhubani	297	534,506	279	297	534,506	279
Khajauli	67	234,068	134	196	551,768	319
TOTAL .	364	769,574	413	493	1,086,274	598

The excess of record-writing over cadastral survey in *thana* Khajauli refers to the area surveyed during the previous season, but of which the record-writing was postponed.

The survey is contained in 629 sheets on the 16-inch scale, and there are 550 additional sheets for the 64-inch scale village site surveys.

The average size of the field was only 0·35 of an acre. The independent *partals* amounted to 932 linear miles, and the Inspector's *partals* to 1,091 linear miles. The total gives an incidence of 4·9 linear miles of test survey to each square mile of detail. In addition to the foregoing, 695 blocks in the village site were resurveyed and 1,461 *partal* lines run through the streets and lanes. In the record-writing the entries against 18,377 fields were checked by the European Survey officers and 371,938 by the Inspectors. The total of 390,315 gives an average of 36 per cent. of the total number of plots.

The records of the entire season's work have been completed, with the exception of 43 villages, the records of which will be ready early in October.

PURNEA.

232. As the traverse surveyors in Monghyr and Patna districts completed their work, they were moved into Purnea and surveyed 854 villages covering an area of 728 square miles.

The origin of this survey is Lat. 25°-50′ and Long. 87°-40′. To check the work 109 azimuths were observed, and the resulting magnetic variation is 2°-04′ East. 12,584 new theodolite stations were fixed and these were marked by 1,743 stones, 10,716 cylinders and 125 pegs. All the computations have been satisfactorily proved and the plots handed over to the cadastral camp for next season's detail survey.

233. In the Gaya district the Maksúdpur estate was surveyed, but as the villages were much scattered no attempt was made to connect the various blocks and the survey will be of no use for the compilation of standard sheets.

BACKERGUNGE DISTRICT.

234. The origin adopted for the traverse survey is Lat. 22°-30′ and Long. 90°-30′.

235. All the surveyors were Bengalis but the *khalasis* were imported from Hazáribágh as they could not be obtained locally.

236. 19,431 traverse stations were fixed and marked, 1,250 by stones, 17,256 by cylinders and 909 by pegs, 16 were on old pillars. The magnetic variation derived from 82 azimuth observations is 1°-36′ east.

237. The country traversed is difficult, as though absolutely flat it is broken up by tidal rivers and narrow winding creeks. A certain amount of opposition was experienced at the commencement, but as precautions had been taken to employ local *amins* in place of the usual line-cutters the progress of the work was not materially affected.

238. The cadastral survey of the Bamna estate was made as a test of the special difficulties likely to be met with in the extended cadastral operations during the next field season. This test survey has proved most useful in showing when the Bihar system must be modified for the district, and as a training ground for *amins*.

The area surveyed was 33 square miles covering 44 villages and 34,588 fields.

SINGHBHUM.

239. The area traversed is 540 square miles enclosing 518 villages.

The origin of survey is the same as that of 1894-96, namely, Lat. 22°-30′ and Long. 86°-00′.

14,405 new stations were fixed, 919 trijunctions being marked by locally cut stones with a triangle and dot chiselled on the flat top. 10,000 clay cylinders were employed on other stations, and the supply of these having failed, stones with a broad arrow cut on them were used to complete the demarcation.

One hundred and thirty four observations for azimuth were taken and the resulting magnetic variation is 1°-42′ east.

Special precautions, such as running two chains and using the subtense bar, were taken to ensure accurate measurements in the hilly tracts.

MISCELLANEOUS SURVEYS.

240. In Champáran 84 square miles of the Rámnagar forest were traversed for the topographical survey of this area, required to enable the standard maps of the district to be completed. The topographical survey was also carried out, and also some demarcation work on the Bhabsa river.

241. In Darbhanga the Madhubani Municipality of 1,164 acres was surveyed, the true urban area of 490 acres on the 64-inch scale and the remainder on the 16-inch scale.

242. In Jalpáiguri the boundary between the Baikuntpur estate and the adjoining Government estate was relaid.

BENGAL DRAWING OFFICE.

243. The preparation of the standard maps of districts Orissa, Bihar and Chittagong was continued. In Orissa there are altogether 32 standard sheets; of these 6 have been published, 3 are under publication and the remainder 23 sheets have been drawn but cannot be published until the names have been corrected in accordance with the Settlement Department *thana* list. In consequence of the changes of spelling, a new edition of the six sheets already published is necessary. In Bihar there are 40 standard sheets; none have up to date been published, but 12 covering Muzaffarpur have been submitted for publication. Fresh editions of these sheets will also be required as the spelling is not in accordance with the Settlement *thana* lists, etc.

Of the Sáran and Champáran sheets, six and four respectively have been submitted for publication, the remainder are drawn, except three in Champáran in which this season's topographical survey has to be inserted, and three in Sáran in which the *diára* tract is still incomplete.

The 2-inch mapping of Darbhanga has been commenced and the Chittagong sheets are well in hand.

PROGRAMME FOR 1901-1902.

244. The following shows the *locale* of the operations for next year with the areas in square miles of the different classes of survey :—

District.	Traverse survey.	Cadastral with records.	Topographical.
Sonthal Parganas—Private estates	1,069	...	...
Monghyr	178	609	41
Patna—Government estates	55	...	...
Gaya—Deo Raj	1,00	...	...
Shahabad—Hathwa Raj estates	2	...	...
Purnea	...	710	...
Bhágalpur	1012	...	...
Singhbhum—Porâhât and Anandapur	260	...	...
Mánbhum—Nagarkiari estate	50	...	...
Ránchi	710	...	...
Backergunge	629	574	16
Kálimpong—Government estate	180	180	...
TOTAL	4,245	2,073	57

245. The officiating Deputy Surveyor-General inspected the Traverse Survey office at Mussooree during September, specially in connection with the changes in the method of computing the coordinates of village traverses, necessitated by the increasing use made of cadastral maps for the compilation of the standard sheets.

UPPER AND LOWER BURMA.

No. 7 Party.

246. Mr. E. G. Little directed operations till the 10th April when he retired on superannuation pension, and Mr. J. Connor assumed charge of the party.

247. The party was divided into five camps, the head-quarters and Lower Chindwin cadastral camp were in charge of the Executive Officer, and the Lower Chindwin traverse camp in charge of Mr. G. W. Jarbo ; Mr. Connor supervised the working of the drawing and arrears camp, while Mr. J. S. Swiney had charge of the traverse camp in Lower Burma.

248. The programme for the year in Upper Burma was to traverse 550 square miles, and cadastrally survey 800 square miles in the Lower Chindwin district. In Lower Burma it consisted of traversing 44 square miles in Sandoway district and 168 square miles in Kyaukpyu district, as estimated by the Land Records Department.

The areas actually traversed were in excess of the programme in the Lower Chindwin, this was done in order to complete the traverse work of the district ; in Lower Burma the areas surveyed were in defect of the programme owing to the villages demarcated for survey in Sandoway district being very widely scattered and surrounded by dense jungle ; this retarded the work to such an extent that the villages of that district alone could not all be traversed, and no work could be undertaken in the Kyaukpyu district. The area to be traversed in the Sandoway district turned out to be considerably in excess of that estimated for survey by the Land Records Department, and there are 5 square miles still left to be traversed.

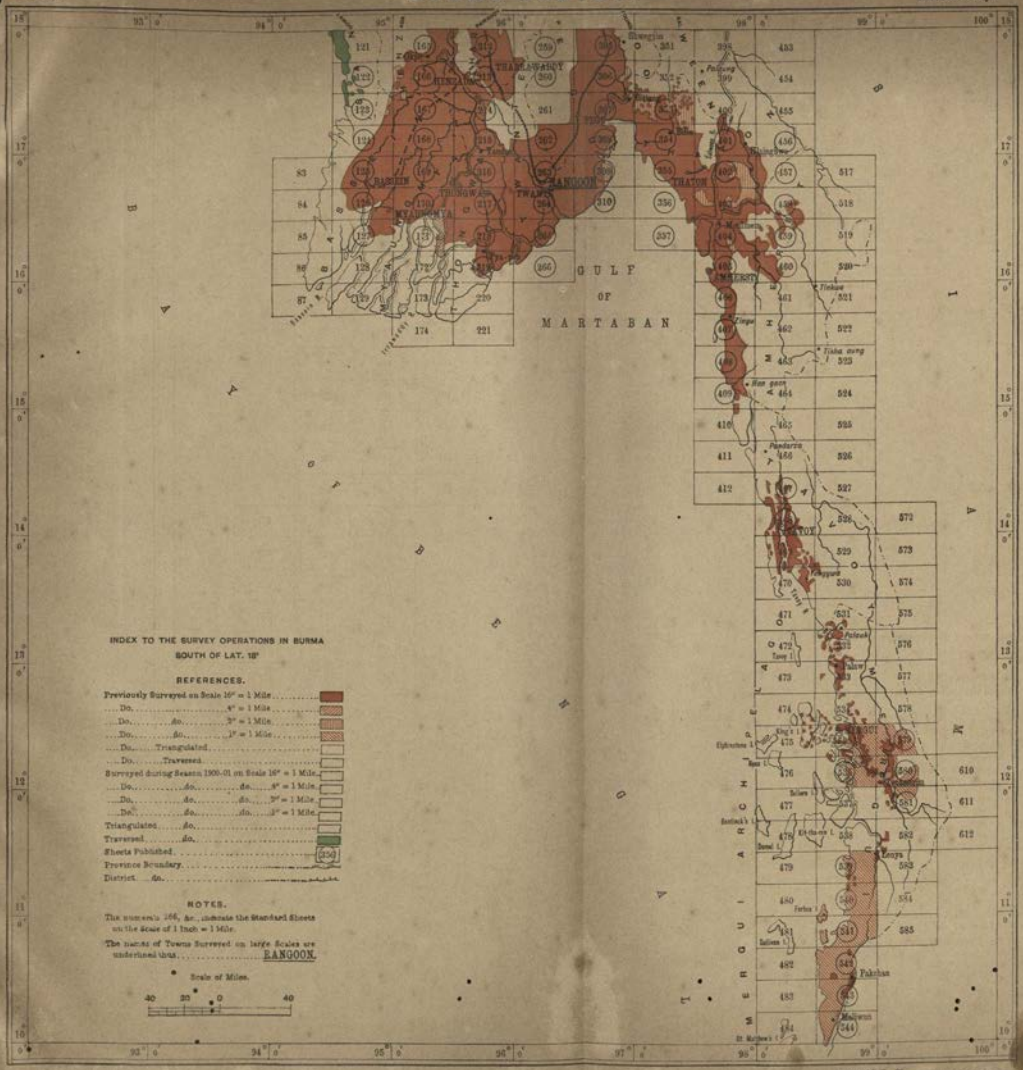
249. The following statement gives particulars of the work done and the cost per square mile.

District.	Traversing.			Cadastral survey.				Scale.
	Villages.	Square miles.	Cost per square mile.	Villages.	Square miles.	Fields.	Cost per square mile.	
		(a)	₹				₹	
Lower Chindwin	*Kwins* 316	666	63	502	808	4,02,110	111	16-inch.
Sandoway	Blocks 33							
	97	105	373	...	...	...	...	...

(a) Includes 14 square miles of riv erarea.

BURMA SURVEY.

INDEX TO THE SURVEY OPERATIONS IN BURMA
NORTH OF LAT. 18°
REFERENCES.
Previously Surveyed on Scale 16" = 1 Mile.
Do. do. 8" = 1 Mile.
Do. do. 4" = 1 Mile.
Do. do. 2" = 1 Mile.
Do. do. 1" = 1 Mile.
Do. Triangulated.
Do. Traversed.
Surveyed during Season 1900-01. on Scale 16" = 1 Mile.
Do. do. do. 8" = 1 Mile.
Do. do. do. 4" = 1 Mile.
Do. do. do. 2" = 1 Mile.
Do. do. do. 1" = 1 Mile.
Triangulated. do.
Traversed do.
Sheets Published.
Provincial Boundary.
District.
NOTES.
The numerals 197, &c., indicate the Standard sheets on the Scale of 1 Inch = 1 Mile.
The names of Towns Surveyed on large Scales are underlined thus MANDALAY.
Scale of Miles.
40 20 0 40
BENGAL
ASSAM
SHAN STATES
SOUTHERN SHAN STATES
Fort O'Connell
MYITKYINA
KATHA
SHAMO
KATHA
MOGOK
MANDALAY
MEIKTILA
YAMETHIN
PAKOKKU
YENANGYAUNG
THAYETMYO
PAUNDE
MINDOWAY
KYAUKPYU
ASHE
PAPUN
Kengtung
Mong Hsat
Mong Pan
Loilem
Mong Nai
Mong Yai
Mong Kung
Mong Pawn
Mong Nawng
Mong Mit
Mong Nai
Mong Hsu
Mong Kyawng
Mong Hsang
Mong Hsaing
Mong Hsaw
Mong Hsaw
Mong Hsaw


INDEX TO THE SURVEY OPERATIONS IN BURMA
SOUTH OF LAT. 18°
REFERENCES.
Previously Surveyed on Scale 16" = 1 Mile
Do. do. 4" = 1 Mile
Do. do. 2" = 1 Mile
Do. do. 1" = 1 Mile
Do. Triangulated
Do. Traversed
Surveyed during Season, 1900-01 on Scale 16" = 1 Mile
Do. do. do. 4" = 1 Mile
Do. do. do. 2" = 1 Mile
Do. do. do. 1" = 1 Mile
Triangulated do.
Traversed do.
Sheets Published
Province Boundary
District do.
NOTES.
The numerals 166, &c., indicate the Standard Sheets on the Scale of 1 Inch = 1 Mile.
The names of Towns Surveyed on large Scales are underlined thus RANGOON.
Scale of Miles.
40 20 0 40
GULF OF MARTABAN
BAY OF BENGAL
ANDAMAN SEA
MERGUI ARCHIPELAGO
RANGOON
THATON
MERGUI
Tavoy
Mergui
Victoria Point
Kawkareik
Pa-an
Thaton
Moulmein
Amherst
Tenasserim
Kyaikto
Thongwa
Twante
Bassein
Henzada
Myaungmya
Maubin
Pegu
Prome
Thayetmyo
Toungoo
Shwegyin
Papun
Salween R.
Sittang R.
Irrawaddy R.
Bassein R.
Rangoon R.
Tavoy R.
Pakchan R.
Mergui R.
Tenasserim R.
Kyaikto R.
Thongwa R.
Twante R.
Pegu R.
Prome R.
Thayetmyo R.
Toungoo R.
Shwegyin R.
Papun R.
Moulmein R.
Amherst R.
Thaton R.
Rangoon R.
Bassein R.
Henzada R.
Myaungmya R.
Maubin R.
Pegu R.
Prome R.
Thayetmyo R.
Toungoo R.
Shwegyin R.
Papun R.

The cost of the survey, both traverse and cadastral combined, in the Lower Chindwin district is about the same as that of the work done in the same district last season.

In Sandoway district the traverse work was exceptional, and the cost is in consequence quite out of proportion to the area. The bulk of this district was cadastrally surveyed under the supervision of the Land Records Department by local agency in 1890 to 1892, and the tracts made over to No. 7 Party for survey consisted of isolated *kwins* situated in dense jungle generally at great distances apart, which had not been surveyed by the Land Records Department.

250. The origins of survey adopted for the different districts are as follows: In Sandoway the origin is the same as used by the Land Records Survey Department, namely, Lat. 18° 30′, Long. 94° 30′, in the Lower Chindwin Lat. 22° 0′, Long. 95° 0′.

Connection to one station of the Trigonometrical survey was made, and 81 azimuths were observed in the Lower Chindwin district, while in Sandoway district connections to two stations of the Trigonometrical survey were made, and 68 azimuths were observed. The chains were tested weekly by the standards laid down in camps, and the sub-surveyors were inspected frequently in the field by the camp officers and their assistants. In Sandoway the traverse survey was connected with the work of the Land Records Department, whose survey marks were found in a fairly good state of preservation. In Lower Chindwin 12,589 theodolite stations were fixed during the season and in Sandoway 4,800 stations. Galvanized iron cylinders were embedded in the ground to permanently mark the stations.

251. The cadastral survey work in the Lower Chindwin district was mapped on 1,090 sheets on the 16-inch scale to check which 2,573·04 linear miles, or an average of 3·18 linear miles per square mile, of test lines were chained by assistants, independent *partallers* and inspectors. As a rule the work was found to be correct, but portions of some sheets had to be revised; this was done at the expense of the men who made the original surveys. The average size of fields in Lower Chindwin district, including jungle, is 1·29 acres.

252. Ten Burmans were trained as field surveyors during the season, and after they had become qualified they were employed on contract work in the same way as the other *amins*, with fair results.

253. The season's work has been completed, and traces of the 16-inch sheets and their area statements submitted to the local authorities.

In addition to the above the local authorities have been furnished with a second set of 16-inch traces of the work of previous seasons in Lower Chindwin district at the request of the Settlement Commissioner. The arrears camp and drawing office managed by Mr. Connor has been engaged on similar work to that stated in last year's report. The following statements show the progress that has been made during the year:—

Mapping of Standard Sheets—2-inch reductions.

Districts.	Sheets submitted for publication previous to 30th September 1900.	Sheets submitted for publication during 1900-1901.	Sheets remaining in hand.	Remarks.
Meiktila	24	...	...	
Upper Chindwin	...	64	...	
Shwebo and Ye-u	65	...	...	
Katha	...	53	...	
Yamèthin	(*a*) 36	...	...	(*a*) Includes 8 sheets recalled for correction of names and boundaries.
Myingyan	15	23	...	
Minbu	17	...	...	(*b*) Number of sheets in Lower Chindwin district not final, as the survey of the district has not been completed yet.
Lower Chindwin	...	...	(*b*) 31	
Magwe	20	27	...	
	(*a*) 177	167	(*b*) 31	

Cadastral Survey Mapping on the 16-inch scale.

Districts.	Sheets submitted for publication previous to 30th September 1900.	Sheets submitted for publication during 1900-1901.	Sheets remaining in hand.	Remarks.
Meiktila	1,486	...	...	
Upper Chindwin	...	893	...	
Shwebo and Ye-u	3,561	...	...	
Katha	1,635	...	...	
Yamèthin	300	1,156	(*c*) 951	(*c*) Includes 373 sheets sent to the Settlement Department for survey of extensions of cultivation, etc.
Myingyan	...	3,958	38	
Minbu	351	44	...	
Lower Chindwin	...	1,427	1,175	
Magwe	2,556	...	...	(*d*) These figures are liable to alteration until settlement operations have been completed.
	10,249	7,478	(*d*) 2,164	

254. The original 16-inch plans of 22 *kwins* of district Yamèthin have been sent to the Settlement Officer, at his request, for re-survey, as many alterations were needed and some omissions have been found in them; these are in addition to the plans referred to in last year's report.

255. The country dealt with in district Lower Chindwin was similar to that surveyed and described in last season's report. In Sandoway the dense mangrove jungle surrounding the *kwins* and through which the traverse lines had to be cut, proved a formidable obstacle to the survey and seriously retarded the progress of the work, thus raising the cost-rate to an abnormally high figure.

256. The health of the establishments in both Lower Chindwin and Sandoway districts was satisfactory on the whole; one temporary sub-surveyor, who contracted malarial fever in Sandoway district, died on his return to recess quarters at Mandalay. The field establishments on arriving from India were quarantined under the plague rules for 10 days, either at Rangoon, or on reaching their Field quarters.

257. The Upper Burma detachments left Mandalay for the field on 6th November 1900 and returned on the 30th May 1901.

The Lower Burma detachments left Mandalay on the 18th November 1900, and returned partly on the 4th June and partly on the 18th June 1901.

258. The drawing and arrears office of the party at Mandalay was inspected by the Surveyor-General accompanied by the Deputy Surveyor-General on the 29th February 1901.

259. The programme for season 1901-1902 is as follows:—

Traverse Survey	700 square miles in	Pakôkku	District.
,, ,,	5 ,, ,,	Sandoway	,,
,, ,,	168 ,, ,,	Kyaukpyu	,,
Cadastral Survey	(*a*)666 ,, ,,	Lower Chindwin	,,
,, ,,	105 ,, ,,	Sandoway	,,

(*a*) This includes 14 square miles of riverain survey.

TRAVERSE SURVEYS.

ASSAM PROVINCIAL SURVEYS (DETACHMENT).

260. This detachment continued its work under the superintendence of Mr. T. Shaw, Superintendent, Provincial Surveys, throughout the year.

261. The areas traversed were again very scattered, lying in both the Surma and Brahmaputra Valleys. The details are given below:—

District Sylhet.

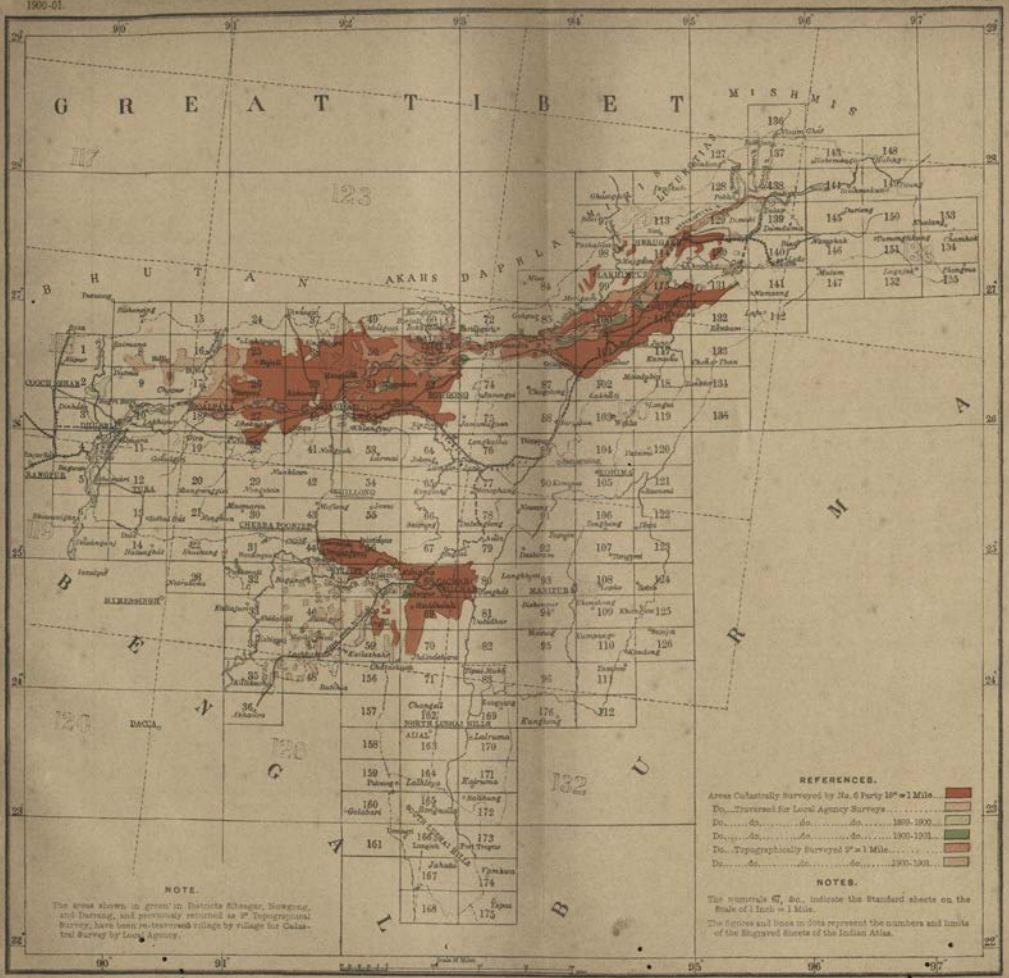
	Square miles.
(i) *Ilam* lands	11·9
(ii) Tea grant applications	2·9
(iii) Disforested areas	14·5
	Linear miles.
(iv) Sylhet and Tippera boundary	4·0

ASSAM SURVEY.

INDEX TO RECENT CADASTRAL, TRAVERSE, & TOPOGL. SURVEYS IN THE BRAHMAPUTRA & SURMA VALLEYS.

1900-01.

ASSAM DETACHMENT.



REFERENCES.

Areas Cadastrally Surveyed by No. 6 Party 16" = 1 Mile.

Do. Traversed for Local Agency Surveys

Do. do. do. do. 1899-1900.

Do. do. do. do. 1900-1901.

Do. Topographically Surveyed 2" = 1 Mile.

Do. do. do. do. 1900-1901.

NOTE.

The areas shown in green in Districts Sibsagar, Nowgong, and Darrang, and previously returned as 2" Topographical Survey, have been re-traversed village by village for Cadastral Survey by Local Agency.

NOTES.

The numerals 67, &c., indicate the Standard sheets on the Scale of 1 Inch = 1 Mile.

The figures and lines in Orts represent the numbers and limits of the Engraved Sheets of the Indian Atlas.

Surv. No. 645, S. I. C.—Nov. 01.—600.

Survey & I. O., Calcutta.

No. 645-S. 01.

265. In Districts Sibságar, Nowgong and Darrang the magnetic meridian was found to be 1°-50′, in District Goálpara 1°-22′, and in Sylhet 1°-42′ east of the true meridian.

266. During the year boundary surveys, in consequence of disputes, were made in Districts Goálpára, Sylhet and the Khási and Jaintia Hills.

The work in District Goálpára was between *Pargana* Habrághát and the Gáro Hills, and the boundary was surveyed to define certain rights claimed by the Rani of Bijni.

The demarcation of four miles of the boundary between Sylhet and independent Hill Tippera was carried out by Mr. O'Donel. The survey in the Khási and Jaintia Hills was undertaken in order to put on record a boundary previously demarcated by the Deputy Commissioner. Through an unfortunate misunderstanding the exact boundary could not be pointed out to Mr. O'Donel at the time of his making his traverse survey, and the work will have to be revised during the coming year.

267. In the greater part of the season's work which fell in areas previously cadastrally surveyed by local agency, it was anticipated that the survey marks existed, and that the survey lines would have been cleared in advance of the sub-surveyors, and that delays on this account would be avoided. In practice, however, it was found that the boundaries ran through heavy jungle, that the survey marks had not been kept up in very many instances, and that the *Mandals* awaited the arrival of the surveyors at each village to assist them in locating the previous survey stations and in clearing the survey lines. Progress was in consequence very slow and the cost-rates high.

268. The cost-rates of traversing per square mile in the several Districts are as shown below:—

		₹
Sylhet	Disforested area	19
	Ilam and grants	119
Nowgong		96
Sibságar		42
Darrang		81

The low rate for the disforested area in District Sylhet is due to the exclusion of Mr. O'Donel's pay and allowances which were debited to Provincial funds.

269. A small area of 38 square miles of the Brahmaputra River was surveyed topographically on the 2-inch scale.

270. The health of the party was fair on the whole and only two deaths took place among the menial establishment.

271. Skeleton plots on the 16-inch scale of 76 villages were supplied to the local authorities during the year.

272. Mr. Shaw examined the maps and records of the Land Records Department in Districts Nowgong, Sibságar, Lakhimpur and Kámrúp, and Mr. O'Donel in District Darrang.

273. A class for training local officers in practical field surveying was held at Jorhát for one month, and nine officers, three extra assistant commissioners and six sub-deputy collectors were instructed by Mr. Shaw, who also conducted examinations for first-class certificates at the Survey Schools at Gauháti, Jorhát and Dibrugarh.

274. The preparation of the 2-inch standard sheets of South Cachar was continued in the drawing office besides other miscellaneous work. This office was inspected by the officiating Deputy Surveyor-General in May, and he is of opinion that the whole question of continuing the present system of Provincial Surveys in Assam requires careful consideration.

CENTRAL PROVINCES.

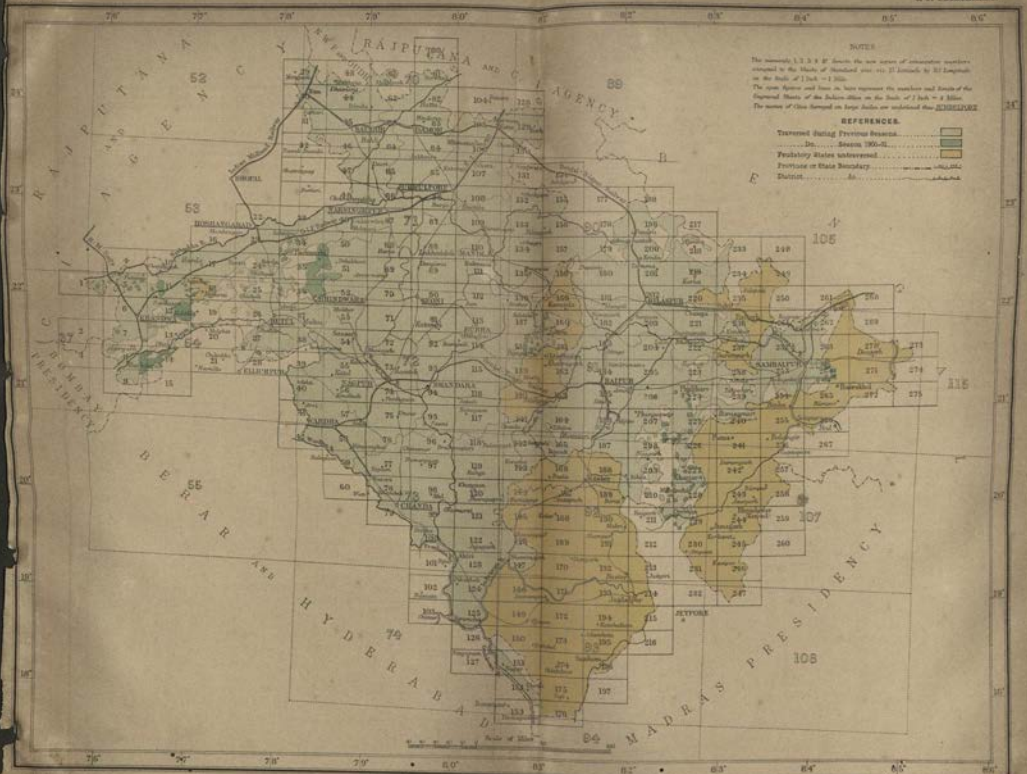
TRAVERSE DETACHMENT.

275. Mr. W. C. Price held charge of the party till his retirement on 22nd June, after which Mr. M. Gastaud held temporary charge till relieved by Mr. R. C. Ewing on 16th August. The operations of this season were confined to the traversing of detached villages in several districts in compliance with the requirements of the Commissioner of Settlements and Agriculture.

CENTRAL PROVINCES SURVEY.

INDEX TO THE TRAVERSE SURVEY IN THE CENTRAL PROVINCES.

1900-01. C. P. DETACHMENT.



276. A Drawing Office was attached to the detachment for the compilation of the standard sheets, and a small revising staff of surveyors was added to revise and correct in the field the maps compiled from the settlement surveys.

277. The traverse section was employed in surveying such areas as the Local Government directed, where plots were required by the *patwaris* for the completion by them of the detail survey on the 16-inch scale.

The following areas formed the programme for the season and were all completed:—

		Polygons.	Area sq. miles.
District	Raipur	88	„ 134
„	Sambalpur	5	„ 19
„	Chhindwára	80	„ 248
„	Nimár	110 | 15*	„ 305
„	Hoshangabad	40	„ 135
„	Betúl	5	„ 3
„	Bálághát	3	„ 1
TOTAL		346	„ 845

* Scattered villages.

278. Of the traverse section, three sub-surveyors were employed in districts Raipur and Sambalpur and seven in districts Chhindwára, Nimár and Hoshangabad. The computers and head-quarters were encamped at Narsinghpur. The drawing section carried on its work in the office at Jubbulpore throughout the year.

(i) In Raipur the area traversed was situated in the *zamindaris*, the villages were very scattered, and much time was spent in going from one to another of the blocks and in searching for the excisions, the positions of which were only roughly known. Much inconvenience and delay was also caused owing to these not having been demarcated in advance.

(ii) Of the five jungle blocks in Sambalpur, one was a portion of Government Reserve Forest, the other four were portions of the district left unsurveyed by the preceding local Cadastral Survey. These blocks were all demarcated in advance.

(iii) In Chhindwára the demarcation was not done in advance but the boundaries were pointed out at time of survey. The *jagirdars* were not helpful and supplies had to be procured from Pachmarhi.

(iv) In Nimár, the demarcation of only 22 out of 110 blocks was done in advance, and a local peon had to be obtained from the *tahsildar* to assist in securing the attendance of the village headmen to point out the boundaries.

(v) In Hoshangabad there was no demarcation done in advance, but the *tahsildars* of Harda and Sohágpur appointed peons to assist, and the *jagirdars* in the Bariam Pagara *jagirs* and the Mahádeo blocks rendered very material assistance by doing the demarcation with their own men and supplying gratuitously auxiliary cooly labour.

(vi) In Betúl five excisions were traversed and connected with previous surveys; they were at long distances apart and much time was spent in marching between them.

(vii) In Bálághát three excisions were traversed. They had been demarcated and no difficulties were experienced.

279. The work consisted of traversing village boundaries and excised portions of Forest Reserves, which were necessarily scattered, on the principles in vogue in all revenue surveys. There were measured 3 main circuits, 8 sub-circuits, 346 village circuits and 429 sub-traverses.

The angular work (11,322 stations) was checked by 18 azimuth observations, the average angular error is 5″.

The linear measurements amount to 1,923 miles, the average error per 100 chains being 7 links; four stations of the Jubbulpore Meridional series were connected with.

280. The stones marking theodolite stations of the previous surveys at the village trijunctions and some others were found on the ground. This season's traverse stations were marked by embedding (about two feet under ground and six inches above) undressed stones marked at top with a circle and dot.

281. The area traversed is 845 square miles, at a cost of R23,825 or 28 per square mile.

282. The character of the country traversed was hilly and jungly, as it consisted of excised portions of original Forest Reserves, or jungle villages which having formerly had annual rentals of less than R15 were omitted by previous local cadastral surveys, but the rents of which now exceed that sum. The detached and scattered positions of the blocks necessitated much line clearing (the lines being generally carried over forest clad hills) in order that the necessary connections for determining their true positions might be made.

283. The party left recess quarters on 27th October 1900 and closed field operations on 15th June, when the establishment returned to Jubbulpore.

284. The computations have been completed, the 16-inch skeleton plots for issue to settlement officers with their numerical data have been supplied to Deputy Commissioners, *viz.*, 976 sheets of 346 villages.

285. The traverse work for the coming season will be 932 square miles, in districts Damoh, Mandla, Seoni, Hoshangabad, Sambalpur and Raipur.

286. The *drawing section* has completed the reduction by pantagraph of 2,529 villages contained in 4,635 cadastral 16-inch sheets of district Jubbulpore, and 1,294 villages, having 3,345 sheets in district Damoh, the details being transferred in blue to field sections measuring $7\frac{1}{2} \times 7\frac{1}{2}$ minutes in graticule: these reductions cover 84 field sections in Jubbulpore and 62 in Damoh, and will be given to field surveyors, whose duty it will be to verify, correct and supplement by careful examination in the field the topographical features transferred to them. During the coming field season a staff of qualified men will be appointed for this special work, and some members of the drawing office have been trained for it during recess. The cost of drawing office was R11,591.

287. The party was inspected on 19th November 1900 by Colonel Hobday, Deputy Surveyor-General, and on 13th April 1901 by Colonel Gore, R.E., Surveyor-General, and Major Longe, R.E., Officiating Deputy Surveyor-General.

PUNJAB.

PUNJAB DETACHMENT.

288. The detachment under the superintendence of Mr. R. B. Smart continued its traverse operations in the Punjab but it was strengthened by a Sub-Assistant Superintendent and six native surveyors and a special drawing office was started in connection with it for the preparation of standard sheets from the *patwari's* large scale village maps, using the traverses as a basis.

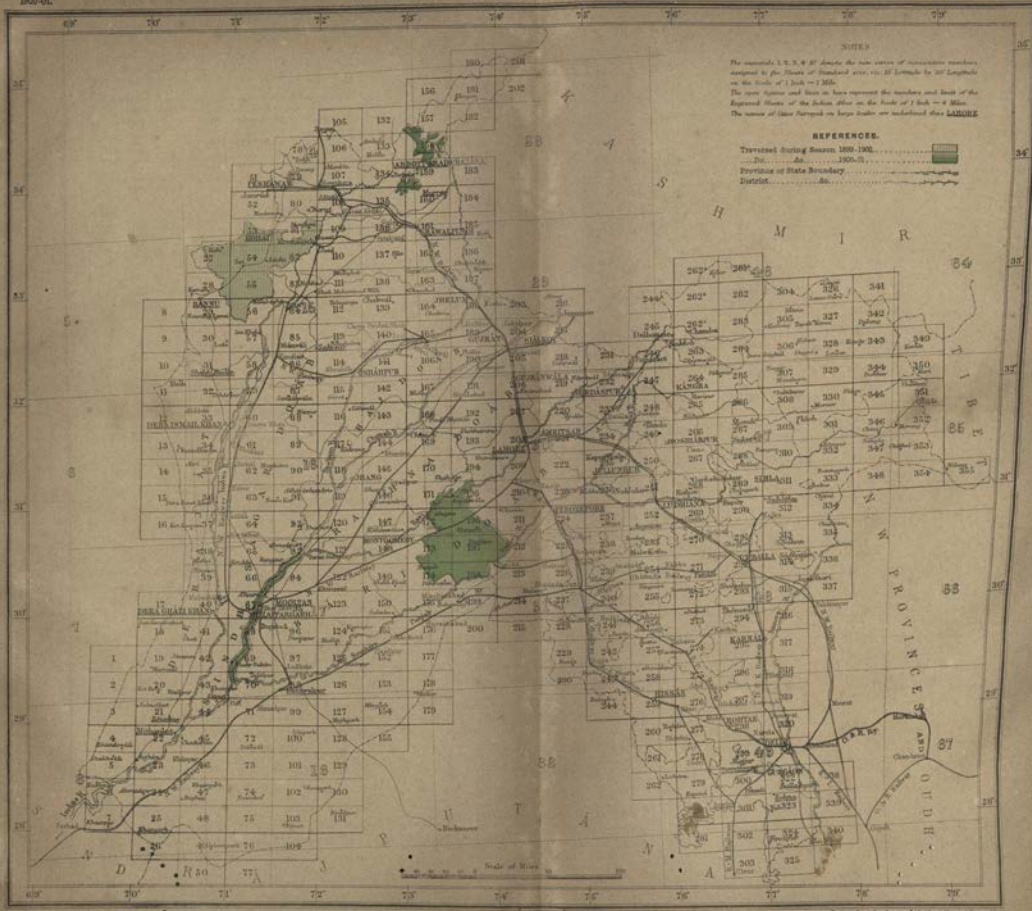
289. The original programme was to run traverses over the Hazára district similarly to the previous year's work in Kohát; and the work was actually commenced, but it was soon found inadvisable to continue it in that district, and on the recommendation of the Surveyor-General the Punjab Government agreed to the immediate transfer of the detachment to Montgomery. The Settlement Commissioner of the Punjab visited the detachment in the Agror valley and concluded that any further work there was unnecessary, as already our 2-inch and 4-inch maps showed the boundaries and our Topographical Survey had fixed all the trijunctions of the villages, and therefore, for Imperial purposes, further traversing was unnecessary. The Punjab Government having agreed to the transfer and the Government of India having sanctioned it, the party started on the 22nd December for Montgomery, and commenced work on the 9th January. Field work was closed on the 26th March, and the office reopened at Mussooree on the 8th April. The whole field season having lasted a little over six months.

290. On transfer to Montgomery the character of the work was somewhat changed. In addition to the ordinary duties of the party, which were to pick up by theodolite traverse the trijunctions of villages and ends of base lines, and to supply their direct distances apart to the settlement officers, a riverain survey of a portion of the Chenab was carried out for the following reasons.

PUNJAB SURVEY.

INDEX TO THE TRAVERSE SURVEY IN THE PUNJAB.

1900-01. PUNJAB DETACHMENT.



Engraved at the Survey of India Offices, Calcutta, 1901.

Photo. S. I. O., Calcutta.

No. 543-S. 01.

291. In the Punjab, as in so many other Provinces in India, the deep stream of the various rivers has hitherto been largely adopted as the boundary of villages, districts or of the Province. Owing to the constant changes of the river bed this has led to a never-ending series of disputes, so that the Punjab Government has determined as far as possible to fix once and for all each boundary independently of the ever-changing course of the rivers. In furtherance of this, a number of the internal riverain boundaries have been settled. Owing to their situation in the river beds no permanent demarcation can be made, so as soon as the settlement officers had laid down such a boundary, the *patwaris* of the villages on either bank, carried their village surveys, by means of their *square* system down into the river beds and entered the newly-determined boundary on their maps. As however, the temporary marks along such boundaries, are sure to be washed away, it becomes part of such a system to be prepared to relay the boundary accurately whenever the rivers change their course. It has been realized that it will not be possible for the *patwari*, with his cumbrous system of squares, to do this sufficiently quickly and accurately, and moreover there would be no certainty that the same boundary laid off from the village maps on either bank would coincide on the ground. The Punjab Government has therefore asked that the Survey Department should construct riverain maps showing the determined boundaries. There would be no difficulty in doing this were these boundaries marked, but the marks have disappeared, and, as above stated, the *patwaris* are not considered capable of relaying them. An attempt is therefore being made to utilize the boundaries as surveyed by the *patwaris* in the following manner:—

A careful traverse is being run along the high banks on either side of the rivers selected. All trijunction marks and the marked ends of the *patwaris* base lines in proximity to the traverse are picked up by the traverser, and cross connections at frequent intervals are made between the two traverses. Subsequently these are plotted on the 8-inch scale, and the *patwari's* maps, reduced to the same scale, are fitted on to the plots by means of their trijunctions and base line stations. The riverain boundary is then inserted from the *patwaris'* maps. If the latter are correct the common boundary plotted from the villages on either side, should agree. If it does so, or very nearly so, it will be accepted and a map prepared from these plots on the 8-inch scale.

No surveying will be done, as it is useless to map the everchanging stream, but such details as can be filled in from the settlement maps will be entered. These maps will subsequently be utilized by trained agency to relay disputed boundaries.

This experiment was during last season carried out on the Chenab river. The plots of the boundary from either side hardly ever agreed absolutely; although for the southern part of the boundary such agreement was fair, in the northern portion, a large discrepancy occurred. This seems to have been due as far as can be seen to the unaccountable missing of one of the 1,100 feet squares from one of the *patwari's* maps, though it appears to have been impossible to locate it.

In the coming year the experiment will be continued, and as some of the riverain boundaries are at present under settlement, every effort will be made to enter them while the marks are on the ground.

292. During the field season in the Hazára district 439 village trijunctions were fixed by the traversers, but the only compact block is one of 14 villages in the Agror valley covering an area formerly divided into 50 villages, as shewn by the survey of 1865-69. A comparison between the work of the year and that of 1865-69 shows that, except where the villages had since been amalgamated, the trijunctions are in the same positions.

In district Montgomery 1,607 trijunctions and 721 base lines were connected; of these only 1,365 trijunctions and 659 base lines were found to be demarcated, the remainder were marked by pegs by the surveyors as pointed out by the *patwaris* and villagers. This incomplete demarcation was in *Tahsils* Gugera, Dipálpur and Pákpattan and it was ascertained that that of *Tahsil* Montgomery was very incomplete, and it is much to be regretted that several of the trijunctions which were not demarcated were incorrectly pointed out by the village authorities on comparison with the reduced village maps.

The traversing of *Tahsil* Dipálpur was completed, and also that of Gugera with the exception of a small portion in the north adjoining Jhang, where the *patwaris* failed to attend and the settlement maps were not sufficiently accurate to admit of their being used for the preparation of the standard sheets; this area will consequently have to be topographically surveyed.

293. The following table gives the actual areas traversed :—

Names of tahsils.	No. of villages.	No. of square miles.	No. of Linear miles.
District Hazára.			
Mánsahra Abbottabad Haripur	179	317	721
Total	179	317	721
District Montgomery.			
Gugera	244	851	761
Dipálpur	478	895	1,305
Pákpattan	127	255	408
Total	849	2,001	2,474
Chenab Riverain area	182	352	392
Total	182	352	392

294. In anticipation of the amalgamation of this detachment with No. 18 Party, 4945 settlement maps on the 24 and 16-inch scales were reduced to that of 2 inches to the mile and transferred to 51 plotted field sections. The details have been inked up in blue with the exception of the village boundaries which are accepted as correct and inked in black These sections will be inked up in the field after examination and from them the standard sheets will be drawn. Of the 849 villages which form the subject of the above mentioned 4945 maps, 814 were on the 24-inch scale and of these 26 cannot be utilised in the compilation of the standard sheets owing to faulty survey, and the majority of the remainder which were surveyed on the 16-inch scale have likewise to be rejected as they are exceedingly incorrect, being mere copies of plans made in previous settlements. In addition several *chaks* could not be fixed owing to their localities being unknown for the moment ; they will be located next field season. The following points were noticed and seem important enough to record :—

(1) There appear to be no recognised symbols or orders as to how roads, canals and water-courses should be shown on the settlement maps and consequently in one *halka* they are shewn one way and in another in some other way, making it almost impossible for the draftsmen to compile the field sections and necessitating very careful revision in the field.

(2) The spelling of the names of the villages on the maps and on the lists of villages to be traversed frequently do not agree, and this as well as the names of all the rivers, etc., will have to be carefully gone into during the revision in the field.

(3) *Thánás*, post offices, and other important buildings are not shown on the settlement maps, and consequently will have to be specially enquired about and fixed by survey during revision.

295. The village reductions have been transferred to 51 field sections, but of these only 36 will be sent into the field owing to it having been decided not to take up the revision survey of Gugera.

296. The angular work was checked by 159 azimuths, and 41 additional azimuths were observed at starting and closing stations of main and sub-circuits.

297. Fifteen principal stations of the Jogi Tila series running through the work were connected, and all the co-ordinates refer to the origin of survey. In addition 9 secondary or intersected points were used to check the traverses.

298. The cost of the party for the year is R51,660, giving an average cost-rate of R20 per square mile, but as the work was of three different types it may be well to note that that in Hazára cost R45, that in Montgomery R11 and the riverain work R23 per square mile. The cost per linear mile traversed in the above sections was R20, R9 and R20 respectively.

The cost of permanently marking stations of the riverain survey with stones came to R1-4-0 per square mile, and that of preparing the plane-table sections from the village maps came to about R3 per square mile. Six of the traverse sub-surveyors were temporarily attached to the survey training school, Dehra, during recess, for instruction in topographical surveying.

The detachment was inspected by Colonel Hobday, Deputy Surveyor-General, during the field season in January, and by the Surveyor-General in August while in recess.

GEODETIC.

ASTRONOMICAL LATITUDES.

No. 22 PARTY.

299. This party, under Lieutenant H. McC. Cowie, R.E., was employed during the season on latitude operations on that portion of the Karáchi Longitudinal Series lying between the meridians of 67° E. and 72° E. Long.

A chain of Astronomical Latitudes, determined at points along the parallel of 24°, and between the meridians of 67° and 87°, has thus been completed.

The observations were taken with Troughton and Simms' Zenith Telescope No. 1, fitted with two levels. Talcott's method of observation was employed. The results are given in the following table:—

TABLE GIVING THE FINAL VALUES FOR THE LATITUDES AND THE APPARENT DEFLECTION OF THE PLUMB LINE AT EACH STATION.

No.	Station.	Number of stars observed.	Astronomical Latitudes =O.	P. E.	Geodetic Latitudes =C.	Apparent deflection of plumb line =O—C.	P. E. of a result of unit-weight.
			° ′ ″	″	° ′ ″	″	″
1	Khankharia . .	92	24 36 58·17	±0·082	24 36 56·19	+1·98	±0·533
2	Didáwa . . .	116	24 51 17·32	±0·036	24 51 19·36	−2·04	±0·259
3	Virária . . .	95	24 56 32·76	±0·035	24 56 36·25	−3·49	±0·235
4	Lánki . . .	69	24 58 18·74	±0·053	24 58 23·16	−4·42	±0·239
5	Rojhra . . .	113	24 57 26·08	±0·032	24 57 26·28	−0·20	±0·234
6	Chánga . . .	105	24 58 47·25	±0·036	24 58 47·00	+0·25	±0·252
7	Khori . . .	98	25 0 30·60	±0·032	25 0 31·53	−0·93	±0·221
8	Alamkhán .	101	24 49 30·50	±0·034	24 49 31·23	−0·73	±0·235
9	Károthol . . .	90	24 53 44·78	±0·028	24 53 46·69	−1·91	±0·185
10	Akbar . . .	45	30 53 38·52	±0·073	30 53 43·26	−4·74	±0·343
11	Ranjitghar . .	27	32 35 6·51	±0·053	32 35 12·10	−5·59	±0·186

300. The results of the season's work show that the geodetic values of latitude are almost always larger than the astronomical throughout the region traversed.

In the selection of stars for observations, two catalogues were used, the Greenwich Ten Year Catalogue for the epoch 1880.0 and the Catalogue of Fundamental Stars for 1900.0 by S. Newcomb, the latter being used in preference to the former, whenever possible. Many of the stars observed occurred in both catalogues; their places were accordingly computed from the data given in each, and the values of the colatitudes so obtained compared. The results of the investigation are given in Table VII in the Narrative Report; these will be published in a volume of the Professional Papers and show that the difference between the results obtained from the use of the two catalogues is constant.

301. The party was inspected by the Superintendent, Trigonometrical Surveys, in August.

EXPERIMENTAL BASE MEASUREMENTS.

No. 23 Party.

302. Capt. G. P. Lenox-Conyngham, R.E., continued in charge of the party, which was specially employed on experimental work throughout the year.

303. The experimental remeasurement of the Dehra Dún Base Line, which was made with the Jäderin apparatus in April 1900, showed that the wires supplied to the Indian Government had not the same co-efficient of expansion as those used by M. Jäderin and described in his pamphlet; an application to the Stockholm firm by whom the apparatus had been made, elicited the information that in place of steel an alloy of nickel and steel, having a very low expansion, had been employed. No values of the expansions of either of the wires, however, were given, and in the absence of these the lengths of the Base could not be computed from the measurements made, nor could any opinion as to the value of M. Jäderin's method be formed.

304. It was imperatively necessary to come to a conclusion as to the advisability of adopting the Jäderin apparatus for the measurement of the Base Lines which will be shortly required in Burma, and it was decided to assign to No. 23 Party the task of elaborating some means of measuring the expansions of the wires and of making the necessary determinations. The task proved a difficult one, but was successfully accomplished by Captain Lenox-Conyngham.

305. An account of the apparatus devised with details of the results obtained has been given in a Professional Paper of the Survey of India Department.

306. The final values of the co-efficients of expansion, as determined by Captain Lenox-Conyngham at Dehra Dún in the spring of 1901, were—

For hard drawn brass	0·0000109	*per* 1° Fahrenheit.
For the alloy of nickel and steel	0·0000002	,, ,,

The observations gave no evidence of the necessity for a second term involving the square of the temperature in the expression for the expansion.

The values of the expansions given by M. Jäderin in the pamphlet are:—

For hard drawn brass	0·0000100 *per* 1° F.
For hard drawn steel	0·0000056 ,, ,, ,,

The agreement between the two values for the expansion of the brass wires is satisfactory; the great reduction of the expansion produced by the addition of nickel to the steel shows how valuable this alloy is for the construction of measuring instruments and standards of length.

307. The expansion of the nickel steel wire is so small that an error of 10° F. in the estimation of the temperature will only produce an error of $\frac{1}{5000000}$ of the length measured (that is to say of $\frac{1}{300}$ th of an inch in the case of these 80 feet wires), which is smaller than other errors to which the measurement of a Base Line is liable.

Thus the use of this metal removes the necessity for very accurate determinations of the temperature, which has always been a chief source of difficulty and uncertainty.

308. The above figures make the coefficient of the new alloy $\frac{1}{28}$th of that of steel. A report read before a conference of the International Geodetic Association at Stuttgart in 1898 stated that an alloy of 36 per cent. of nickel to 64 of steel had a coefficient of only $\frac{1}{50}$th of that of steel. We are unfortunately not aware of the composition of our wires, so that no inference can be drawn from the difference between the Stuttgart and Dehra Dún determinations.

309. The determinations of these coefficients occupied the party during the field season; in the recess season the recomputation of the experimental measurement of the Dehra Dún Base was taken up with the following results:—

	Feet.	Miles.	Yards.	Feet.	Inch.
1st measurement	39,187·171 =	7	742	1	2·06
2nd ,,	39,187·373 =	7	742	1	4·47

Discrepancy = 0·202 = $\frac{1}{196,000}$ of the length.

Mean of the two values 39,187·272 feet.
Length by measurement with the Colby Bars 39,187·462

Discrepancy = 0·190 = $\frac{1}{206,000}$ of the length.

310. These results are satisfactory, for there is good reason to believe that the experience gained will lead to such improvements in the procedure as will materially increase the accuracy of the work. The apparatus which was constructed for the determination of the expansions of the wires will be of great use when actual Base Lines come to be measured in Burma; the admirable behaviour of the wires, when subjected to close scrutiny under powerful microscopes, has created a confidence in their trustworthiness as measuring instruments which it was difficult for observers accustomed to the laborious refinements of the compensation bars to feel.

TIDAL AND LEVELLING OPERATIONS.

No. 25 Party.

311. Captain H. L. Crosthwait, R.E., continued in charge of the Party during the year, except for 15 days in October, when he was on privilege leave and Mr. E. J. Connor held charge.

Tidal Operations.

312. During the last 27 years tidal observations have been taken at 41 stations; of these the following were under observation at the commencement of the year:—

	Stations. (Those shown in italics are *permanent.*)	Date of commencement of operations.	No. of years observed.	Remarks.
1	Suez	1897	4	
2	Perim	1893	3	
3	*Aden*	1879	21	
4	Bushire	1892	8	Closed during year.
5	*Karáchi*	1881	20	
6	Porbandar	1898	3	"personal" observations were previously taken.
7	Port Albert Victor (Káthiàwádar)	1900	1	do. do.
8	*Bombay* (Apollo Bandar)	1878	23	
9	Bombay (Prince's Dock)	1888	13	
10	*Madras*	1895	6	previous observations from 1880 to 1890.
11	*Kidderpore*	1881	20	
12	*Rangoon*	1880	21	
13	*Port Blair*	1880	21	

313. During the year under review the station at Bushire was closed. An observatory will be opened at Bassein in Burma next field season.

314. The tidal observatories at work were all inspected during the year, either by Captain Crosthwait or Mr. Shaw.

315. All the tidal observatories have worked satisfactorily with the exception of Porbandar, where the registrations ceased from the 14th June, owing to the communication pipe being choked with sand driven in by the Monsoon. As this is the second year that this has occurred, steps will be taken at the next inspection to ascertain whether it is worth while continuing the observations.

316. The following tables give a summary of the percentage of errors in the predicted times and heights of high and low water for the last 10 years.

PERCENTAGE OF ERROR IN PREDICTED TIMES AND HEIGHTS AT OPEN COAST STATIONS FROM AUTOMATIC OBSERVATIONS.

YEAR.	No. of stations.	IN TIME.		IN HEIGHT.			
		Within 15 minutes of Actuals.		Within 8 inches of Actuals.		Within $\frac{1}{10}$ of mean range at Springs.	
		H. W.	L. W.	H. W.	L. W.	H. W.	L. W.
1891	10	74	73	94	87	98	97
1892	8	75	74	91	85	98	98
1893	9	73	68	93	98	96	95
1894	10	65	62	95	92	97	95
1895	9	68	65	98	97	94	94
1896	9	71	70	97	97	97	93
1897	8	71	75	96	97	97	97
1898	9	74	70	96	96	95	95
1899	9	74	66	95	95	93	92
1900	11	66	60	93	88	93	89
Average of 10 years	9	71	63	95	93	96	95

PERCENTAGE OF ERROR IN PREDICTED TIMES AND HEIGHTS AT RIVERAIN STATIONS FROM AUTOMATIC OBSERVATIONS.

YEAR.	No. of stations.	IN TIME.		IN HEIGHT.			
		Within 15 minutes of Actuals.		Within 8 inches of Actuals.		Within $\frac{1}{10}$ of mean range at Springs.	
		H. W.	L. W.	H. W.	L. W.	H. W.	L. W.
1891	3	64	58	66	66	92	92
1892	2	61	60	72	65	94	95
1893	2	57	57	68	50	89	84
1894	2	56	55	66	42	88	80
1895	2	59	55	74	47	94	84
1896	2	56	55	63	42	87	74
1897	2	59	61	75	57	96	91
1898	2	53	59	71	61	90	91
1899	2	55	59	76	65	95	94
1900	2	59	62	70	57	89	87
Average of 10 years	2	58	58	70	55	91	87

SPIRIT-LEVELLING OPERATIONS.

317. The levelling detachment worked again on the Eastern Bengal State Railway, commencing at Dámukdia Ghát, where the Ganges river was crossed, and thence along the railway line, closing at Siliguri.

Doubt had been thrown on the method hitherto adopted in the survey of India Department of carrying lines of levels across broad rivers: it had been urged that the level of the water on one side of a rapid river might be several inches and even feet higher than that on the other, and that consequently simultaneous readings of the height of the water on graduated poles, erected near the two banks, did not afford any clue to the real difference in level of the zeros of the two poles. There is a bend in the Ganges near Dámukdia, which made it a particularly unsuitable place for the employment of tide-poles. For these reasons it was decided to erect a bench mark on each bank near Dámukdia and to determine their difference of height by three different methods: the results were as follows:—

	feet.
(1) By means of vertical angles taken simultaneously by two observers with 24-inch theodolites: difference of height	2·139 ± 0·005
(2) By simultaneous observations to disc signals with standard levels: difference of height . . .	2·132 ± 0·016
(3) By simultaneous readings of the height of the water on graduated staves: difference of height . . .	2·211 ± 0·001

The results by the two first methods are affected by similar errors of refraction and their agreement may be fictitious; the tide-pole method differs from the mean of the other two by less than an inch, and the uncertainty of refraction renders the mean of the two first results not reliable to an inch.

The following conclusions may be drawn from the observations:—(i) that the method of crossing rivers by means of graduated tide-poles, even at bends which appear unfavourable, is not liable to appreciable error; (ii) that the method of vertical angles is superior to that of levelling.

318. The total rises and falls amounted to 1,954 feet, and the outturn of work to 211 miles of double levelling, in the course of which the instruments were set up at 2,558 stations and the heights of 26 embedded and 86 inscribed bench-marks, 1 railway bench-mark, and 1 station of the Great Trigonometrical Survey, were determined.

The detachment left Dehra Dún on the 26th October 1900 and closed work on the 27th April 1901.

319. During the next Field Season, the Sonákhoda Base Line will be connected, and levelling operations will be carried on from Párbatipur up the Brahmaputra River and thence towards Assam.

320. The party was inspected by the Superintendent, Trigonometrical Surveys, in September.

MAGNETIC.

NO. 26 PARTY.

321. The work of this party commenced on the 12th December 1900, on which date Captain H. A. D. Fraser, R. E., arrived in Dehra Dún from England and took over charge of it. Before leaving England this officer had completed arrangements for the purchase of the necessary instruments, for which purpose he had been sent on deputation.

322. Under the general scheme for the Magnetic Survey of India, observations for declination, dip, and intensity are to be taken at points between 30 and 40 miles apart, distributed over the country; at certain stations, known as "repeat" stations, these observations will be repeated annually until the survey is completed. Base stations are to be established at Colaba, Kodaikánal, Dehra Dún, Madhupur and Rangoon; at these five places magnetic observatories will be built, and self-recording instruments installed.

323. It was intended to start field work in October 1901, and the interval was employed in training observers, computers and recorders.

324. It had been hoped that the self-recording instruments would have been installed at the Base Stations during the summer, but unforeseen delays have occurred in the construction of the observatories.

325. The new observatory at Rangoon has been completed, and it is hoped to set up the instruments there in the early part of 1902. The new observatory at Kodaikánal is still under construction, but it is hoped that it will be put in working order by next April. The new observatory at Dehra Dún was completed about the end of April, and the instruments were temporarily erected and worked for a few days in May. During last rains, however, certain defects in the building showed themselves, which prevented the permanent installation of the instruments till they could be remedied, and consequently the observatory is not yet in working order.

326. The comparison of the Kew and Colaba standard magnetometers has been completed, and the results will be published separately with the annual report of the party. They show that these standards are in close agreement with one another.

327. The field work for the ensuing field season will be confined to the area lying west of the line joining Dehra Dún and Bombay, and only three field parties are to be employed instead of five, though the latter strength will be attained in subsequent seasons. Two of these parties will work along railway lines, and the third will move in the Rájputána desert. Owing to lack of previous experience the first season's work must be regarded as to some extent experimental, though it is confidently expected that the results will prove sufficiently trustworthy to permit of their being accepted as part of the survey.

TABULAR STATEMENTS.

SUMMARY OF THE OUTTURN OF WORK OF THE FIELD PARTIES DURING THE YEAR 1900-01.

Summary of the outturn of work of th

Scale of Survey.	Number of Party.	Locale of Field Operations.		Triangulation.				1st Class.			Secondary.			Tertiary.		Spirit-Levelling Operations.		
				Instrument used. Diameter in inches.	Area in square miles.	Square miles to each point trigonometrically fixed.	Square miles to each height.	Stations fixed.	Triangular error in seconds.	Error per mile in feet.	Stations fixed.	Triangular error in seconds.	Error per mile in feet.	Intersected points.	Error per mile in feet.	Miles levelled over.	Permanent bench-marks connected.	Trigonometrical stations connected with.
Inches to a mile. 105·6	18	Himalayas	...	5 & 6	...	...	...	...	...	...	...	...	...	...	...	...	...	...
24	15	North-West Frontier	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
16	Provincial Surveys.	N.-W. Provinces, Azamgarh	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		" " Gonda	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		" " Farrukhabad.	5	5 & 6	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		" " Mainpuri	...	5 & 6	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		" " Etáwah	...	5 & 6	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		" " Etah	...	5 & 6	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		" " Aligarh	...	5	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		" " Jálaun	10	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		" " Hamírpur	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	Bengal Survey.	Bengal, Sonthal Parganas	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		" Singhbhum	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		" Purnea	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		" Jalpáiguri	15	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		" Backergunge	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		" Monghyr	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		" Gnya	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		" Patna	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		" Darbhanga	20	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	7	Upper Burma, Lower Chindwin.	...	5 & 6	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Lower Burma, Sandoway	...	5 & 6	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	17	Bombay Forests	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	21	Hsi Paw Town and Environs (Northern Shan States).	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	Detachment.	Punjab	25	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	Detachment.	Central Provinces, Chhindwára Jagirs	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		" " Hoshangabad.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		" " Nimár	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		" " Raipur	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		" " Sambalpur.	30	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		" " Bálághát	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		" " Betúl	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	Provincial Surveys.	Assam, Sylhet	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		" Goálpára	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		" Nowgong	35	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		" Sibságar	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		" Darrang	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		" Khási and Jaintia Hills.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		TOTAL	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
12	12	Sind	40	6	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	15	North-West Frontier	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		TOTAL	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
8	17	Bombay Forests	...	5	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Carried over	44	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...

Field Parties during the year 1900 01.

	TRAVERSING.				DETAIL SURVEY.					RECORD-WRITING.			REMARKS.
	Area in square miles.	Number of stations at which the theodolite was set up.	Angular error per station in seconds.	Linear error per mille.	Area in square miles.	Plane-table fixings per square mile.	Linear miles of test lines.	Villages.	Average size of fields.	Area in square miles.	Villages.	Fields.	
...	...	1,220	3·92	1·59	...	..	...	...	...	...	...	...	
...	...	...	...	...	0·8	...	...	...	...	...	...	...	
...	111	....	...	...	590	...	5,136	1,557	·34	472	1,236	845,172	
...	...	..	...	...	782	...	4,142	909	·37	784	909	1,514,031	
5	292	3,919	8	...	447	...	1,716	373	2·5	589	459	363,947	
...	616	11,918	8	7·5	447	...	2,637	453	·83	666	512	515,414	
...	461	7,613	6	...	55	...	101	56	1·1	25	27	13,035	
...	189	2,326	6	...	671	...	1,981	648	1·0	506	506	413,342	
...	180	2,988	2	...	147	...	2,301	51	2·86	147	51	77,914	
10	730	12,576	8·6	3·1	605	...	1,828	279	2·5	480	273	146,728	
...	35	584	6	...	...	...	...	...	...	...	...	...	
...	735	18,880	...	...	...	...	...	...	...	...	...	...	
...	540	16,109	...	...	...	...	...	...	...	...	...	...	
...	728	15,904	...	...	...	...	...	...	...	...	...	...	
15	...	397	...	...	...	...	...	...	...	...	...	...	
...	608	22,313	...	...	33	...	233	44 (a)	...	33	44	34,588	(a) Includes 13 villages=26 square miles of 16-inch topographical survey.
...	747	14,582	...	...	767 (a)	...	4,371	1,197	...	729	1,180	793,282	
...	128	4,107	...	...	...	...	...	... (b)	...	...	...	...	(b) Includes 4 villages=11 square miles of 16-inch topographical survey.
...	60	442	...	...	67 (b)	...	202	22	...	56	18	8,476	
20	65	1,733	...	...	414	...	2,026	365	...	598	494	1,093,631	
...	666 (c)	12,589	2·9	0·48	808	...	2,573	502	1·29	...	...	...	(c) Includes 14 square miles of river area.
...	105	6,035	4·6	1·8	...	...	...	...	...	...	...	...	
...	...	...	...	...	11	209	24	...	...	...	...	...	
...	...	...	...	...	8	...	12	...	...	...	...	...	
25	2,670	10,220	2·1	0·48	...	...	...	...	...	...	...	...	
...	248	3,249	·7	1·4	...	...	...	...	...	...	...	...	
...	135	1,323	·3	·9	...	...	...	...	...	...	...	...	
...	305	3,791	·4	·6	...	...	...	...	..	...	...	...	
...	134	2,644	·4	·6	...	...	...	...	...	...	...	...	
30	19	153	·1	1·9	...	...	...	...	...	...	...	...	
...	1	66	·1	·5	...	...	...	...	...	...	...	...	
...	3	96	·1	1·2	...	...	...	...	...	...	...	...	
...	81	1,968	...	0·2	...	...	...	...	...	...	...	...	
...	...	180	...	...	...	...	...	...	...	...	...	...	
35	30	496	...	...	...	...	...	...	...	...	...	...	
...	110	2,377	...	...	...	...	...	...	...	...	...	...	
...	16	451	...	...	...	...	...	...	...	...	...	...	
...	...	66	...	...	...	...	...	...	...	...	...	...	
...	10,749	...	...	...	6,052	...	...	...	...	5,085	...	...	
40	...	100	42	·2	3	11	96	...	...	...	...	...	
...	...	...	...	...	32	698	87	...	...	...	...	...	
...	...	...	...	...	35	...	...	...	...	...	...	...	
...	...	452	...	...	255	215	243	...	...	...	...	...	
44	...	...	...	...	6,342·8	...	...	...	...	5,085	...	...	

Summary of the outturn of work of th

Scale of Survey.	Number of Party.	Locale of Field Operations.		Triangulation: Instrument used. Diameter in inches.	Triangulation: Area in square miles.	Triangulation: Square miles to each point trigonometrically fixed.	Triangulation: Square miles to each height.	1st Class: Stations fixed.	1st Class: Triangular error in seconds.	1st Class: Error per mile in feet.	Secondary: Stations fixed.	Secondary: Triangular error in seconds.	Secondary: Error per mile in feet.	Tertiary: Intersected points.	Tertiary: Error per mile in feet.	Spirit-Levelling Operations: Miles levelled over.	Permanent bench-marks connected.	Trigonometrical stations
Inches to a mile.		Brought forward	45	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
4	9 & 19	Madras Forests, Kurnool	...	6 & 7	1,335	1·6	1·8	...	...	...	136	19·3	·6	676	1·7	...	...	...
		" " Coimbatore	...															
		" " Cuddapah	...															
		" " South Canara	...															
	17	Bombay Forests	50	6 & 7	381	1·3	1·3	...	...	...	251	15	·5	1,466	·6	...	...	...
	18	Himalayas	...	7	50	1·4	1·4	...	...	...	7	12	0·79	28	0·17	...	...	...
	Forest Branch.	Burma Forests	...	6	534	20	20	...	...	...	9	9·5	0·7	4	0·4	...	...	...
		Central Provinces, Mandla and Damoh	...	5	404	1·0	1·0	...	...	...	127	15	1·3	256	2·8	...	...	...
		" " Seoni	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		" " Nimár	55	6	65	2·7	2·7	...	...	...	6	10	0·7	17	0·7	...	...	...
		" " Chánda	...	6	293	16·2	17·2	...	...	...	7	14	1·8	9	0·6	...	...	...
		Bengal, Singhbhum	...	6 & 7	650	6·8	8·1	...	...	...	35	16	0·5	55	1·3	...	...	...
		Punjab, Hazára	...	7	340	2·7	2·7	...	...	...	18	16	0·6	106	1·5	...	...	...
		" Jubbal and Tarhoch States	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		TOTAL	60	...	4,052	...	...	...	...	...	...	...	...	...	...	...	...	...
2	3	Lower Burma	...	5 & 6	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	12	Sind	...	7 & 8	3,729	11	11·3	...	...	...	86	6·4	0·2	203	0·34	...	...	...
	15	North-West Frontier	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	"	" " "	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	18	Himalayas	65	7	85	1·6	...	...	...	...	...	...	...	53	0·01	...	...	...
	Provincial Surveys.	Bengal, Champáran	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Assam, Lakhimpur	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	Forest Branch.	Burma	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		TOTAL	...	...	3,814	...	...	...	...	...	...	...	...	...	...	...	...	...
1	3	Lower Burma	70	6	600	15	20	...	...	...	8	5	0·4	26	0·7	...	...	...
	10	Upper Burma	...	6	4,068	6·3	6·5	...	...	...	50	7·2	0·10	394	0·33	...	...	...
	11	" "	...	6	3,311	5·2	6·4	...	...	...	47	10·4	0·22	611	0·47	...	...	...
	14	Lushai	...	6 & 7	1,904	111·7 1·4	111·7 1·4		5·6	0·11	39	17·8	0·25	649	...	...	...	...
	15	Sind	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	18	North-West Frontier	75	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Himalayas	...	5	105	2·3	...	...	...	...	6	20	0·57	39	1·3	...	...	...
	21	Upper Burma	...	6	3,375	7·5	7·5	...	...	...	30	14·2	0·31	458	0·56	...	...	...
		TOTAL	...	...	13,363	...	...	...	...	...	...	...	...	...	...	...	...	...
½	15	Kashmir	...	...	4,800	...	...	...	...	...	...	...	...	...	...	...	...	...
		North-West Frontier	80	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		TOTAL	...	...	4,800	...	...	...	...	...	...	...	...	...	...	...	...	...
¼ & ⅛	15	North-West Frontier	...	...	18,350	...	...	...	...	...	...	...	...	...	...	...	...	...
	25	India	...	...	...	...	...	...	...	...	...	...	...	...	...	211	26	1
		GRAND TOTAL	84	...	44,379	...	...	...	...	...	...	...	...	...	...	...	...	...

Field Parties during the year 1900-01—contd.

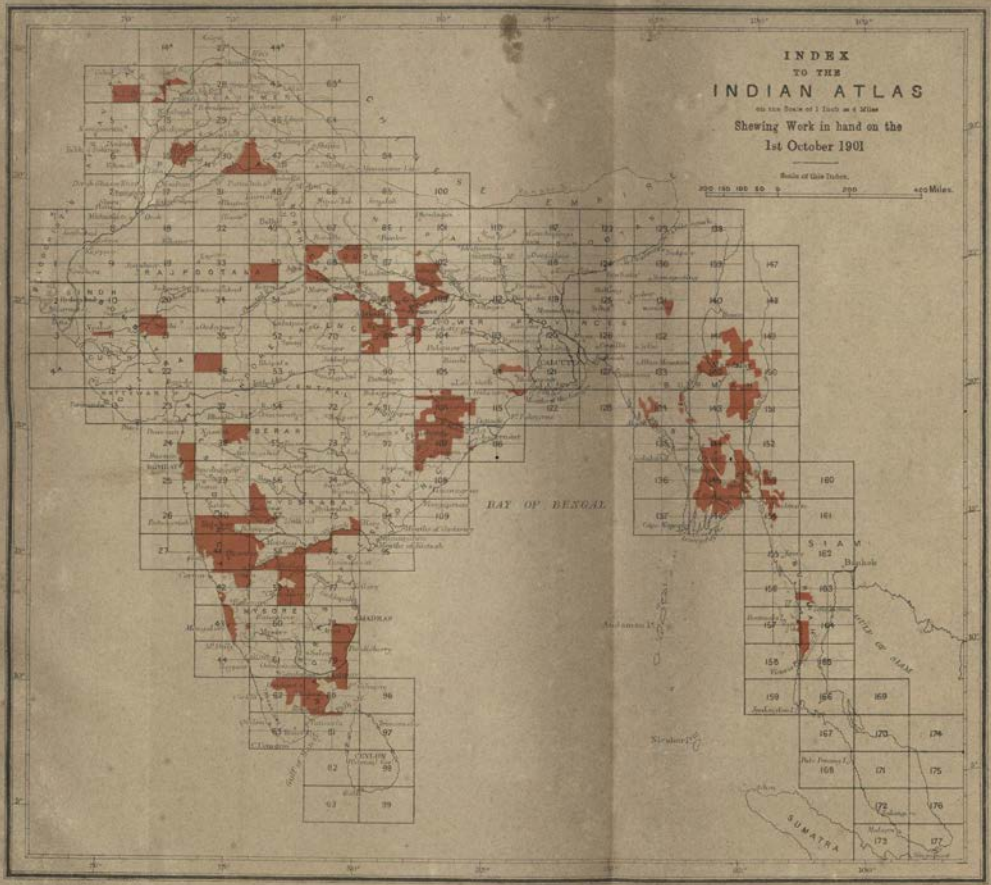
	TRAVERSING.				DETAIL SURVEY.					RECORD-WRITING.			REMARKS.
	Area in square miles.	Number of stations at which the theodolite was set up.	Angular error per station in seconds.	Linear error per mille.	Area in square miles.	Plane-table fixings per square mile.	Linear miles of test lines.	Villages.	Average size of fields.	Area in square miles.	Villages.	Fields.	
45	...	...	...	...	6342·8	...	...	...	...	5,085	...	...	
...	...	1,189	2·0	0·7	398	72	74	...	...	...	...	...	
...	...	...	...	...	232	43	24	...	...	...	...	...	
...	...	2,079	9·0	1·6	552	32	27	...	...	...	...	...	
...	...	3,822	8	2·5	196	86	...	...	...	...	...	...	
50	...	1,629	·07	·1	410	124	132	...	...	...	...	...	
...	...	...	...	...	109	15	*in situ*	...	...	...	...	...	
...	1,238	...	...	...	873	134	304	...	...	...	...	...	
...	105	934	10	2·1	780	163	273	...	...	...	...	...	
...	...	350	4	2·7	...	...	...	...	...	...	...	...	
55	...	...	...	...	...	...	...	...	...	...	...	...	
...	76	806	7·5	3·5	776	115	1,095	...	...	...	...	...	
...	128	2,064	0·9	5·3	361	218	107	...	...	...	...	...	
...	...	...	...	...	...	...	...	...	...	...	...	...	
...	...	...	...	...	43	...	...	...	...	...	...	...	
60	...	...	...	...	4,730	...	...	...	...	...	...	...	
...	74	896	6	3	202	84	66	...	...	...	...	...	
...	...	6,199	49	1·2	2,553	23	1,320	...	...	...	...	...	
...	...	...	...	...	440	...	...	...	...	...	...	...	
...	...	...	...	...	120	...	...	...	...	...	...	...	
65	...	...	...	...	951	29	*in situ*	...	...	...	...	...	
...	84	684	...	...	84	...	57	...	...	...	...	...	
...	...	...	...	...	38	...	...	...	...	...	...	...	
...	...	...	...	...	5	62	*in situ*	...	...	...	...	...	
...	...	...	...	...	4,393	...	...	...	...	...	...	...	
70	...	...	...	...	900	9·9	*in situ*	...	...	...	...	...	
					230 (*d*)								
...	...	...	...	...	1,285	4·2	403	...	...	...	...	...	(*d*) Revision survey.
					2,023 (*d*)	4·6(*d*)							
...	...	...	...	...	2,472 (*e*)	95	295	...	...	...	...	...	(*e*) Includes 45·45 square miles of overlap.
...	...	...	...	...	870	2·3	*in situ*	...	...	...	...	...	
...	...	...	...	...	1,915	5·4	110	...	...	...	...	...	
75	...	...	...	...	440	...	...	...	...	...	...	...	
...	...	...	...	...	488	2	*in situ*	...	...	...	...	...	
...	...	...	...	...	1,793	5·3	*in situ*	...	...	...	...	...	
...	...	...	...	...	12,416	...	...	...	...	...	...	...	
...	...	...	...	...	2,124	3·2	77 & *in situ*	...	...	...	...	...	
80	...	...	...	...	1,100	...	...	...	...	...	...	...	
...	...	...	...	...	3,224	...	...	...	...	...	...	...	
...	...	...	...	...	17,000	...	...	...	...	...	...	...	
...	...	...	...	...	...	...	...	...	...	...	...	...	
84	...	...	...	...	48,105·8	...	...	...	...	5,085	...	...	

Statement showing the cost-rates of work executed by th

Number of Party.	Nature and locale of field operations.	Cost-rate per square mile.								
		Triangulation.	Traversing.	½"	1"	2"	4"	8"	12"	16"
	Topographical Surveys.	₹	₹	₹	₹	₹	₹	₹	₹	₹
3	Lower Burma	12·1	67·9	...	43·6	141·0	...	...	...	...
10	Upper Burma	4·9	...	...	26·2 22·3 (*f*)	...	...	...	...	...
11	Upper Burma	11·8	...	...	20·1	...	...	...	...	...
12	Sind	4·5	2″= 6·7 12″=31·7	...	...	12·0 2·8 (*b*)	...	...	105 125 (*c*)	...
14	Lushai	27·9 (*g*) 11·3 (*r*)	...	...	68·3	...	...	...	...	...
15	Kashmir	½″=1·5	...	7·1	...	...	...	...	...	...
	North-West Frontier	¼″=0·8	...	...	2·2	5·3	...	...	780·8	...
	Sind	...	...	...	11·0	...	...	...	...	...
18	Himalaya	45·1	...	...	25·3	60·1	78·3	...	...	...
21	Upper Burma	7·5	...	...	21·4	...	...	...	...	1,299·2
	Forest Surveys.									
9 & 19	Madras		8·8 (*s*)	...	...	...	58·0	...	...	...
17	Bombay	4″= 8·4 8″=14·7	...	...	...	...	65·4	106·7	...	113·0
Forest Branch.	Burma	33·5	...	...	...	80·0	97·8	..	...	...
	Central Provinces	2·7	...	...	...	...	36·9	...	...	...
	Singhbhum	2·1	...	...	...	...	61·3	...	...	...
	Punjab-Jubbal and Tarhoch States	...	....	...	...	...	47·0	...	...	...
	Cadastral Surveys.									
Provincial Surveys.	North-Western Provinces	...	23·8	...	...	...	...	...	...	75
Bengal Surveys and Detachments.	North Bihar	...	31·8	...	...	...	...	...	...	81·8
	Sonthal Parganas	...	52·1	...	...	...	...	...	...	...
	Gaya	...	34·6	...	...	...	...	...	...	...
	Singhbhum	...	54·2	...	...	...	...	...	...	...
	Backergunge	...	60·2	...	...	...	...	...	...	228·8
7	Lower Chindwin, Upper Burma	...	56·3	...	...	...	...	...	...	111·0
	Sandoway, Lower Burma	...	363·8	...	...	...	...	...	...	...
	Traverse Surveys.									
Detachment.	Punjab	...	19·4	...	...	...	...	...	...	...
Do.	Central Provinces	...	27·1	...	...	...	...	...	...	...
Provincial Surveys.	Sylhet	...	118·8 (*t*) 18·6 (*u*)	...	...	...	...	...	...	...
	Nowgong	...	95·8	...	...	...	...	...	...	...
	Sibságar	...	42·5	...	...	...	...	...	...	...
	Darrang	...	81·0	...	...	...	...	...	...	...
	Lakhimpur	...	...	...	...	3·8	...	...	...	...

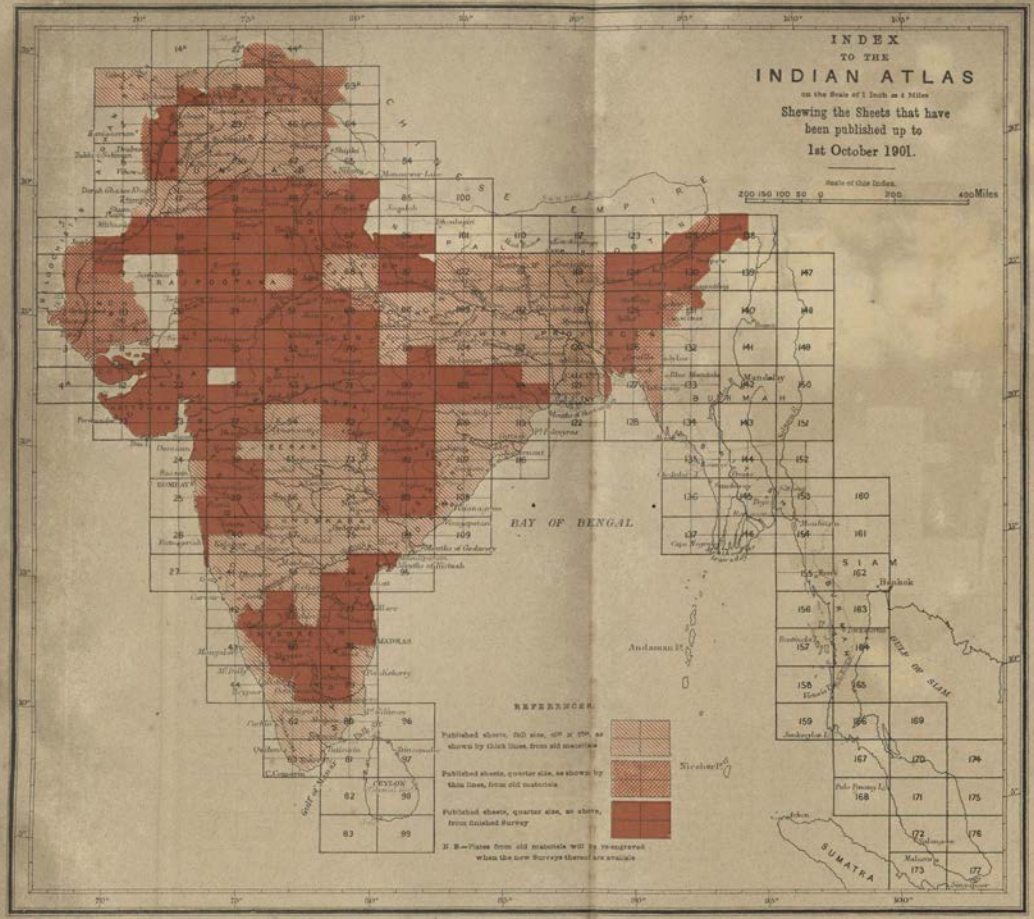
Several Field Parties during the year 1900-01.

	Cost-rate per acre.	Cost-rate per square mile.			Total cost, inclusive of charges for instruments to Provincial Governments.	Remarks.
	Cadastral survey, including traversing, detail survey, and mapping.	Stone embedding.	Records (*Khanapuri*).	Completion of Vernacular records, assessment statistics, etc.		
	Annas.	₹	₹	₹	₹	
	...	...	...	...	89,889	
	...	...	...	...	98,997 (a)	(a) Exclusive of ₹5,636 cost of Bangalore Drawing Office.
	...	...	...	...	88,768	(b) Rate of mapping Khairpur Survey.
	...	...	...	...	87,787	(c) Rate of mapping Karáchi Cantonment.
5	...	...	...	...	96,561	(d) Includes ₹8,019 expended on arrears of mapping.
	...	...	...	...		(e) Includes ₹25,523 for arrears of mapping, ₹3,145 for instruction of soldier surveyors and pupils; ₹4,557 for Simla Survey and ₹3,207 for reduction and compilation of 2" sheets from Patwari maps.
	...	...	...	...		(f) Includes ₹68 expended on 1" detail survey and ₹17,095 on miscellaneous compilation.
	...	...	...	...	1,21,090 (d)	(g) Includes ₹69,930 cost of 1,237 linear miles of traversing.
	...	...	...	...		(h) Includes ₹1,508 cost of 181 linear miles of traversing; ₹3,678 cost of 1,094 miles of boundary survey and ₹868 cost of 829 miles of levelling.
	...	...	...	...		(i) Includes ₹3,085 cost of 127 linear miles of traversing.
10	...	...	...	...	1,00,471 (e)	(j) Includes ₹15,287 cost of Bareilly mapping on 2" scale.
	...	...	...	...	93,200 (f)	(k) Includes ₹4,266, expended on Jalpáiguri-Baikuntpur boundary survey, ₹792 on Thána mapping and ₹4,747 on Orissa and Bihar Bádars.
	...	...	...	...	93,335	(l) Includes ₹569 expended on Mandalay Cantonment and ₹21,358 on completion of traverse and cadastral records of districts surveyed during seasons, 1892-1899.
	...	...	...	...	62,350	(m) Includes ₹500 expended on revision survey in Pegu, and ₹7,921 on printing Rangoon Town maps.
	...	...	...	...	1,73,433 (g)	(n) Includes ₹1,591, cost of Jubbulpore and Damoh mapping.
15	...	...	...	...	65,221 (h)	(o) Includes ₹930 expended on Gosipára and Gáro Hills Boundary survey; ₹2,245 on standard mapping and ₹14,538 charge of Drawing Office.
	...	...	...	...	26,547 (i)	(p) Rate of revision survey.
	...	...	...	...	2,928	(q) Rate of tertiary triangulation.
	...	3·2	...	...	3,41,732 (j)	(r) Rate of first-class secondary do.
	2·84	1·9	74·1			(s) Rate of both triangulation and traversing.
20	...	3·3	...			(t) Ham and grants.
	...	5·6	...	...	4,52,947 (k)	(v) Disforested.
	...	1·7	...			
	7·22	15·0	220·2			
	4·18	6·3	...	...	1,52,382 (l)	
25	...	9·2	...	...	47,572 (m)	
	...	...	...	...	31,660	
	...	1·1	...	...	35,416 (n)	
	...	...	...	...		
	...	...	...	...		
30	...	...	...	...	26,161 (o)	
	...	...	...	...		
32	...	...	...	...		



Reg. No. 4510. I. D.—Dec. 01.—400.

Litho., S. I. O., Calcutta.


INDEX
TO THE
INDIAN ATLAS
on the Scale of 1 Inch = 4 Miles
Shewing the Sheets that have been published up to
1st October 1901.
Scale of this Index.
200 150 100 50 0 200 400 Miles
BAY OF BENGAL
Andaman Is.
Nicobar Is.
SIAM
Bankok
GULF OF SIAM
SUMATRA
CEYLON
MADRAS
REFERENCES.
Published sheets, full size, 40' x 27', as shewn by thick lines, from old materials
Published sheets, quarter size, as shewn by thin lines, from old materials.
Published sheets, quarter size, as above, from finished Survey
N. B.—Plates from old materials will be re-engraved when the new Surveys thereof are available

Surj. No. 486, S. I. D.—Dec. 01.—750.

Litho., S. I. O., Calcutta.

APPENDIX.

Narrative report of MAJOR T. F. B. RENNY-TAILYOUR, *R.E., Superintendent 2nd grade, on the Survey Operations with the China Field Force, season 1900-1901.*

The survey party detailed for the China Field Force under Lieutenant-General Sir A. Gaselee, K.C.B., is given in the margin.

Major T. F. B. Renny-Tailyour, R.E.
Captain C. H. D. Ryder, R.E.
Munshi Ikbaluddin, K.S.
Surveyor Abdul Rahim, K.S.
Surveyor Natha Singh.
Sub-Surveyor Hazrat Ali.
1 Interpreter and 29 *Khalasis*.

At the time of deciding to send an expedition from India to China the outlook was so doubtful that it was considered advisable to delay the despatch of a Survey Party until it appeared certain that operations would actually take place. Consequently it was not until the 15th July 1900 that orders for the survey party were issued.

I left Bangalore for Calcutta with Munshi Ikbaluddin and the surveyors on the 20th July.

Captain Ryder received orders on his arrival at Shanghai to join the expedition and left there for the front on the 21st July.

The *khalasis*, who were supplied by No. 15 Party and came from the neighbourhood of Rawalpindi, joined me at Calcutta. In addition to the ordinary equipment, which was supplied by the Dehra Dún office, I took two Perambulators. The tents for the party, as laid down in the Field Service Regulations, Intelligence and Surveys, were obtained from the Ordnance Department at Calcutta, and clothing, etc., from the Commissariat Department at Calcutta. On field service, surveyors, sub-surveyors and *khalasis* have relative rank as native officers, havildars and sepoys for the scale of allowance of tentage, baggage, rations, etc., but for clothing they are also allowed in addition such articles of the equipment authorized for followers as may be necessary, this is sanctioned in letter No. 248-W, dated 2nd May 1895, from the Military Department to the Surveyor-General of India.

The Survey Party was ordered to leave Calcutta on the 2nd August in the S. S. "*Rewa*" which had also a squadron of the 16th B. L. on board. The "*Rewa*" was a comfortable steamer but rolled badly, and we had a fairly rough passage, losing twenty horses and mules. We called at Hong Kong and Wei-Hai-Wei, and arrived early on the 24th August at the Taku anchorage, about ten miles from the shore, where an enormous number of warships and transports of all nationalities were collected. We were transhipped into a small steamer and landed the same evening at Sinho, the British depôt near Taku. Next day we proceeded by rail to Tientsin which presented an extraordinary sight; the streets were crowded with an endless variety of foreign troops, many of whom were passing through on their way to Peking. The bank of the Pei Ho (river) alongside the Foreign Concessions was covered with stores of all descriptions, and the river itself crowded with boats, the larger of which were being unloaded of stores brought up from Taku, while the smaller ones were loading up for Peking and the Posts *en route*.

On my arrival at Tientsin I wired for orders to the Chief of the Staff at Peking, suggesting that I should send a small detachment there for Captain Ryder, and start the survey work myself at Tientsin before moving on.

The telegraph line was not working properly, and it was some time before I received a reply ordering me to proceed to Peking and to survey the Pei Ho and the roads along its banks on my way. While awaiting this reply I had time to complete a triangulation in the neighbourhood of Tientsin and started Surveyor Natha Singh on a 1-inch survey of the town and the country round about. It was impossible to make an extensive triangulation here, owing to the flatness of the country.

Leaving Natha Singh with some *khalasis* and the heavy baggage at Tientsin, I started with the remainder of the party for Peking on the 9th September, surveying the river and roads as ordered. Our baggage was carried in boats as far as Tungchou, from which place Peking is about 14 miles distant by road. On the 17th September we arrived at Peking, where I met Captain Ryder who had joined at Tientsin from Shanghai in time to accompany the International Force which relieved the Peking Legations on the 14th of August; he had done a certain amount of surveying assisted by the Intelligence surveyors. After my arrival in Peking the field offices of the Intelligence and Survey were practically one, and the military surveyors worked so much under Captain Ryder and myself that it would be impossible to altogether separate the work done by the surveyors of the different branches.

As there were a large number of villages and most of the country to be surveyed was in the plains, I decided that the plane-tabling should be on the half inch scale. I started triangulation; measured a base; observed for latitude and azimuth; and in a short time had relatively fixed the principal hills within sight of Peking, as well as prominent points in the plains.

At first we were unable to move much out into the country, but the surveyors had plenty of work, making large scale plans inside the city, and compiling maps of the neighbourhood from surveys made by the Japanese prior to the disturbances.

Munshi Ikbaluddin started off on the 9th of October on a reconnaissance to the south-west; and on the 12th I set out with an International expedition under Lieutenant-General Sir A. Gaselee, K.C.B., for Pao-ting-fu; I took Abdul Rahim and Hazrat Ali with me, and there were also two military surveyors. A column was also sent from Tientsin to combine with us, and I arranged for Natha Singh to accompany it. Pao-ting-fu is situated about 100 miles to the south-west of Peking.

We were not opposed by the Chinese, and arrived at Pao-ting-fu on the 19th of October, the Tientsin column with Natha Singh arriving the following day. As the road was entirely in the plains and the weather generally hazy it was impossible to carry on a connected triangulation *en route*; I was, however, able to fix our position at several points, by observations to hills already fixed from Peking.

At Pao-ting-fu we were able to rescue several Europeans who had been very badly treated and had had several narrow escapes. A number of Europeans had been murdered here some months before, and an International Commission was appointed to enquire into the matter. Punishments were inflicted on the town, and the principal official and several others were beheaded.

During our halt at Pao-ting-fu I measured a base and did some triangulation; I also observed for azimuth and latitude, and by this means was able to connect on to the Peking series. Abdul Rahim accompanied a small column sent out to the west and did some useful mapping.

We started back from Pao-ting-fu on the 28th, leaving a garrison of French and German troops. It was arranged that the columns returning to Peking and Tientsin should split up and march back by several new roads, and, as a surveyor was sent with each party, we were enabled to get in a good deal of new country. The party I accompanied made a considerable detour to the east and arrived at Peking on the 6th of November.

Soon after my return permission was obtained to send Captain Wingate of the Intelligence and also a Survey detachment with a German column proceeding to Kalgan, about 120 miles to the north-west of Peking and on the outer Great Wall. This detachment consisted of Captain Ryder, Ikbaluddin and Hazrat Ali with one military surveyor, and started on the 12th of November. Owing to the long marches in pursuit of continually retreating Chinese troops no triangulation was possible, but a route traverse was kept up all the way. At Kalgan reliable information was obtained regarding the murder of Captain Watts-Jones, R.E., which had taken place some seven marches to the west, in the month of July. As the German column was returning by the same route, Captain Ryder decided to send Ikbaluddin back with it to fill in additional detail, while he with Captain Wingate returned by a new and more circuitous path through the hills, rejoining the Germans at Ch'ang-pi'ng-chou near the Ming Tombs about a week later, and from there making a small detour in the plains before returning to Peking on the 6th of December.

Surveyor Natha Singh came up to Peking from Tientsin on the 21st of November with the remainder of the *khalasis* and the heavy baggage.

Owing to the severe winter very little surveying was practicable for the next two or three months, and it was not until March that we again got the surveyors regularly out into the country. During these months we were fully employed compiling maps etc., principally with a view to the possibility of expeditions in the spring to the south and south-west. Great use was made of Chinese maps which in this part of China appear to be very fairly accurate in the plains, although the delineation of the hilly country is weird in the extreme. The translating of the names alone was a considerable undertaking.

Captain Ryder proceeded in March to Shan-hai-kuan, started a triangulation there and continued it to Tong-Shan, where he joined a column of about 200 men under Major Turner, Jodhpur Lancers, detailed as an escort for himself, Natha Singh and a military surveyor. In spite of hazy weather he managed to carry on and eventually connected his triangulation on to my Peking series.

A similar column under Colonel Phayre, 3rd Bo.C., with whom I sent Surveyor Abdul Rahim with Hazrat Ali and a military surveyor, working from Peking, met Major Turner's column at the Eastern Tombs, and between them a very large amount of country was surveyed up to the Great Wall.

Besides these columns, from March until the end of June we were able to obtain numerous small escorts, generally under an officer, which kept us very busy, and, with sometimes as many as ten military surveyors working in addition to the Survey Party, a large block of country was mapped in detail.

Surveying becomes quite impracticable in the plains in this part of China during the rains, which commence early in July, and as there was no prospect of being allowed to survey further afield, it was decided that the Survey Party should return to India about the middle of July.

Two draftsmen of the Intelligence arrived from Simla at the beginning of June. This additional help enabled us to reproduce, before our departure, preliminary maps for the use of the troops remaining behind.

The Survey Party left Peking on the 14th of July, and returned to India in the S. S. "*Sumatra*," arriving at Calcutta on the 2nd of August 1901.

Altogether the triangulation of 16,000 square miles of country was completed. As it was impossible for us to obtain our own longitude accurately we based our work on the Naval value of the Shan-hai-kuan lighthouse. The triangulation has been carefully computed at Bangalore, and the connection between the Shan-hai-kuan and Peking series

has proved very satisfactory, the Pao-ting-fu series also connecting well on to the Peking series.

There is thus a good continuous reconnaissance triangulation right round from Shan-hai-kuan to Pao-ting-fu.

The actual surveying in detail on the half-inch scale was carried on by means of plane-tabling, and a total area of 17,000 square miles was completed.

Owing to the hazy weather and the flat nature of the country it was impossible to use triangulated points for a great deal of the work, but, by means of accurate traverses by our own surveyors, the country was fairly well divided up, and thus a good check obtained of the work of the other surveyors. The Perambulators came in very useful for these traverses.

The military surveyors are of course not in the same class as the trained surveyors of the Survey Department, but their work, with a certain amount of adjustment, has generally fitted in wonderfully well; the final maps, drawn on the return of the Survey Party to Bangalore, and based on the triangulation and on the accurate work of our own surveyors, are very satisfactory and quite sufficient for all general purposes.

Without the intimate and cordial relations, which always existed on the expedition between the Intelligence Branch under Captain Norie and ourselves, it would have been quite impossible to have obtained anything like such good results; great assistance was also rendered by Doctor Gatrell, who was attached to the Head-Quarters as Interpreter, in the transliteration of the Chinese names, for which the official system (Wade's) was always adopted.

We had occasional communications with Captain Koenemann, the Officer in charge of the Survey Party with the German army. We gave them some assistance, and received in return a trace of a considerable area of country surveyed by them to the south of our own work. They did not attempt any triangulation, but their work, which was in the plains, appears to be very accurate; it was, I believe, done by officers and chained throughout.

On landing at Taku the country presents one dead level, but as Peking is approached ranges of hills appear to the west and north; these hills continue eastwards towards the sea, till at Shan-hai-kuan they are within three miles of the coast. The whole of the plain is well cultivated and studded with large and prosperous villages, except near the coast, where mud flats abound, relieved here and there by salt heaps, the collection of which forms a most important industry. The crops when full grown rise to 15 or 16 feet in height and absolutely prevent any extended view of the country being obtained.

The weather encountered was extremely annoying to a surveyor and at no season of the year was there a certainty of having two consecutive clear days. In the rains although the atmosphere is clearer clouds hang about the higher hills, in the cold weather there is an almost continuous haze, while the hot weather is no better. This haze is probably largely due to duststorms emanating from the bleak Manchurian plateau.

It is probable that there is a greater range of temperature in North China than in any other part of the world, the temperature in the shade varying from 100° (Fahr.) in the summer to below zero in the winter. In spite of this, the climate is not unhealthy, and good food is everywhere obtainable.

A plentiful supply of warm clothing was issued to the Force, and the good health of the party was in no small measure due to this precaution.

Captain Ryder is a very experienced surveyor and rendered me invaluable assistance throughout; his knowledge of the Chinese was extremely useful.

Munshi Ikbaluddin is very energetic and hard-working, and showed considerable tact in his dealing with military and other officers.

Surveyor Abdul Rahim is a very quick and experienced surveyor, he is most trustworthy and has a great knack of getting on with anyone whom he comes in contact.

Surveyor Natha Singh is a good and capable surveyor, and may always be relied on to bring in neat and accurate work.

Sub-Surveyor Hazrat Ali's knowledge of Chinese was most useful, he is very zealous and promises to turn out well.

APPENDIX.

Mean monthly readings of earth thermometers taken at the Trigonometrical Branch Office, Dehra Dún.

Depth in feet of thermometer bulbs below surface of ground.	Year.	October.	November.	December.	January.	February.	March.	April.	May.	June.	July.	August.	September.
25·6	1900-01	78·42	78·14	77·64	76·84	75·57	74·17	73·28	73·26	73·80	74·65	76·56	78·33
	Mean, 1881—1900	76·92	76·95	76·27	76·22	75·67	74·99	74·48	74·12	74·18	74·49	75·75	76·75
12·8	1900-01	79·60	78·21	76·61	73·92	71·22	69·92	70·52	72·83	75·42	78·05	80·04	80·54
	Mean, 1881—1900	79·43	78·17	76·06	73·55	71·80	70·88	71·43	73·21	75·32	77·36	79·20	79·72
6·4	1900-01	79·34	76·51	72·92	67·37	65·52	66·04	70·54	75·67	80·34	82·81	81·93	81·02
	Mean, 1881—1900	79·77	75·95	71·38	67·38	65·65	67·17	71·67	76·93	80·42	81·43	81·52	81·23
3·2	1900-01	77·52	73·20	66·44	60·41	61·04	65·57	75·27	82·53	87·45	86·39	82·35	81·57
	Mean, 1881—1900	78·39	72·96	65·80	62·01	61·44	66·90	75·66	82·35	84·93	83·40	82·22	81·74
1·1	1900-01	75·23	70·47	60·46	55·47	58·24	66·53	77·90	87·33	93·18	87·49	81·69	81·02
	Mean, 1881—1900	76·50	67·90	60·30	57·39	58·87	67·86	78·75	86·31	88·03	84·14	82·49	81·56
Thermometer in shade	1900-01	79·20	74·36	64·26	60·07	64·41	76·70	86·25	91·67	96·7	85·02	79·76	81·42
	Mean, 1881—1900	80·72	73·43	61·57	64·20	66·92	78·97	89·48	93·65	90·15	82·49	80·83	82·46

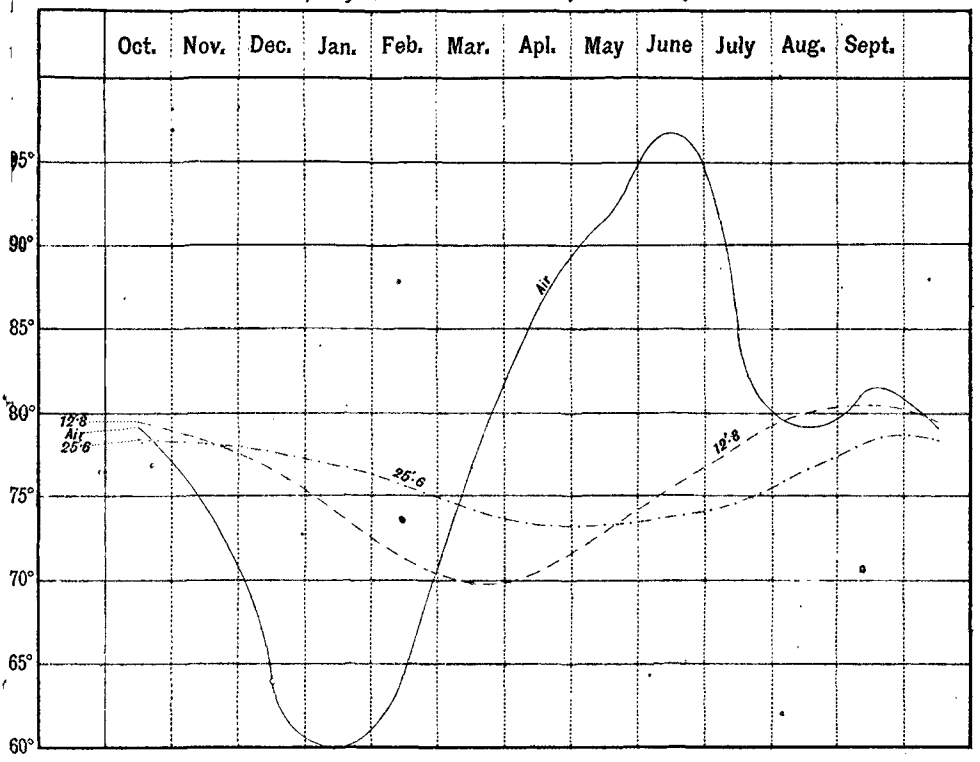
See para. 71 of this report which gives remarks on these figures and the diagram on the opposite page.

Curves of Mean Monthly Readings of Earth Thermometers taken at the

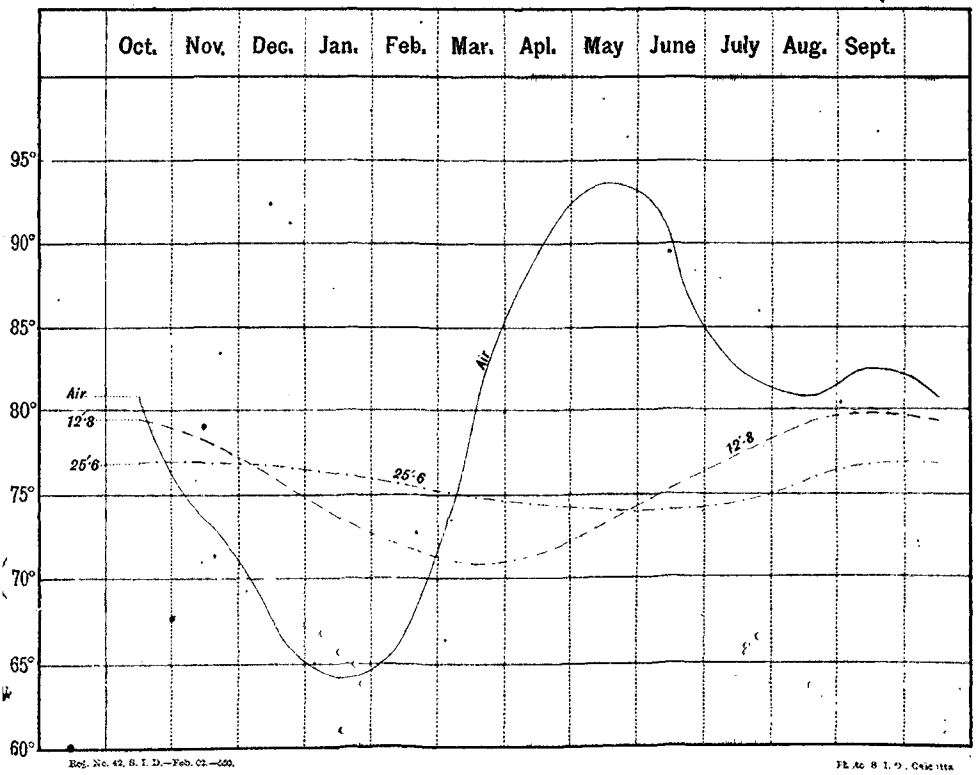
Trigonometrical Branch Office Dehra Dun.

for 1900-01

Depth of Earth Thermometers 12·8 feet and 25·6 feet.



Similar curves for the mean of the years 1881—1901.



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GOVERNMENT OF INDIA.

Serial No. 2.

DEPARTMENT OF REVENUE AND AGRICULTURE.

LAND-SURVEYS.

RESOLUTION

No. 7-87—2.

Dated Simla, the 25th August 1902.

SUBJECT.

Reviews the General Report on the operations of the Survey of India Department for 1900-01.

G. C. Press, Simla.—No. 623 R. & A. D.—27-8-1902.—745.

DEPARTMENT OF REVENUE AND AGRICULTURE.

File No. 87 of 1902.
Serial No. 2.

Simla, the 25th August 1902.

No. 7-Land-Surveys.

Resolution by the Government of India, Department of Revenue and Agriculture.

READ—

The General Report on the operations of the Survey of India Department during the year 1900-01.

Field operations were carried on by one double and sixteen ordinary parties and three detachments; one party was employed on trigonometrical, and eight on topographical surveys; one double and one ordinary party on Forest Surveys, two on cadastral surveys, three detachments on traverse surveys and four parties on scientific operations. In addition to the above, traverse and cadastral surveys were continued in the United Provinces by local agency under the general superintendence of the Deputy Surveyor General. Special Surveys of Government Forests were also carried out by the Forest Survey Branch. The total outturn of detail survey during the year amounted to 65,106 square miles, which included reconnaissance surveys of 17,000 square miles on the $\frac{1}{4}$ inch and smaller scales; and 17,000 square miles on the $\frac{1}{2}$ inch scale which were surveyed in China. The area of detail survey effected was considerably less than in the previous year owing to the absence of reconnaissance work on the North East Frontier. The total area of rigorous surveys on all scales was 31,106 square miles; the total area triangulated, excluding 16,000 square miles completed by the survey detachment with the China Field Force, was 44,379 square miles; while the total area traversed for cadastral surveys was 6,997 square miles.

2. The Government of India have read with interest the account of the operations of the Survey Party under Major Renny-Tailyour, which accompanied the China Field Force, and succeeded, with the aid of the Intelligence Department, in mapping in detail the large area of 17,000 square miles. In Kashmir and on the North-West Frontier large areas were also surveyed; while the deputation of a Sub-Surveyor with Dr. Stein on his recent expedition added considerably to the geographical knowledge of Central Asia.

3. Of the eight parties engaged on topographical operations, four were employed in Burma, one on the Lushai Hills of Assam, and one in the Kangra and Simla districts. The Assam party will shortly be transferred to the United Provinces for topographical purposes, and the Simla party, which has practically completed its programme, will in future be employed in the plains of the Punjab in compiling topographical maps from materials supplied by the Settlement Maps. Nos. 11 and 12 parties, which have for some years been employed in the survey of the Shan States, will be amalgamated. These changes are in accordance with the policy of curtailing topographical operations in remote tracts, prescribed in the Resolution on the report for 1899-1900. Unless there are strong administrative or other reasons for the survey of the remote parts of Sandoway, Thayetmyo, Pegu and Toungoo, the Government of India are disposed to think that it will probably be better to discontinue these surveys. It is understood that the question is at present engaging the attention of the Surveyor General, and the Government of India will be glad to be favoured with a further report on the matter.

4. Cadastral survey operations were conducted in Bengal, the United Provinces and in Burma. In Bengal, a considerable extension of traverse and cadastral surveys took place during the year. The high cost of the cadastral survey in Darbhanga has again attracted the attention of the Government of India. The Government of Bengal have recently been addressed on this point and it is hoped that it will be found possible to effect substantial economies in the conduct of these operations. The Provincial Surveys in the United

Provinces were controlled with efficiency and economy under Mr. G. B. Scott, Superintendent, Survey of India, who has since retired, and whose long and valuable services in the Department His Excellency the Governor General in Council has much pleasure in acknowledging. It is hoped that the arrangements effected for the traverse survey in Allahabad will obviate the need for further traverses at a later date. The extent to which revisional survey has been found necessary in Burma, in order to render the cadastral maps available for topographical purposes, indicates the importance of including in cadastral survey all topographical features, and the Government of India are glad to observe that in the survey now in progress in the United Provinces this consideration is being borne in mind.

5. During the year Forest Surveys were carried out in Madras, Bombay, Burma, Bengal, the Central Provinces and the Punjab. The total outturn of these surveys on various scales amounted to 4,892 square miles, of which 2,838 square miles were surveyed by the Forest Survey Branch. In their review of the report for 1899-1900, the Government of India drew special attention to the need for economy in these surveys, and they now notice with satisfaction the decrease in the cost rates in Bombay. At the same time they have to express their regret at the losses from fever and plague sustained by both the Madras and Bombay Parties.

6. Turning to the scientific work undertaken by the Department during the year, a party was employed during the season in the determination of astronomical latitudes in the Karachi Longitudinal series; while a second party was employed with satisfactory results on experimental work connected with the Jäderin Base line apparatus. Tidal observations were continued as usual. Preparations for the commencement of the Magnetic Survey continued during the year, and arrangements have been made for the establishment of Base stations at Bombay, Kodaikanal, Dehra Dun, Calcutta and Rangoon, at which magnetic observatories will be built and self-recording instruments installed. At Bombay and Calcutta such observations have been recorded for many years. The recent introduction of electric Tramways in Calcutta, and their impending construction in Bombay, have rendered it necessary to arrange for the construction of new observatories at some distance from the two cities, at a distance beyond the effects of the electric current. Considerable progress was made in the preparation of the new series of professional survey papers, which will in future take the place of the technical papers appended to former reports.

7. At the head quarter offices much useful work has been accomplished in the revision and publication of maps, the out-turn of the Photo-Lithographic office being exceptionally large. The use of the Vandyke process to which reference was made last year has effected, as was anticipated, an enormous saving of time and expense in the reproduction of field maps. The Government of India notice with satisfaction the progress made in the Mathematical Instrument Office in the conversion and repair of the stock of old instruments.

8. His Excellency the Governor General in Council again desires to acknowledge the efficient manner in which the Department has worked under the able direction of Colonel Gore.

9. The report under review gives a concise and interesting account of the operations of the year. The instructions for its curtailment which were issued last year have effected a considerable improvement in its form and arrangement.

Ordered, that the above Resolution be forwarded to the Surveyor-General of India, the Inspector-General of Forests, the Local Governments and Administrations noted in the margin and to the Foreign, Military and Public Works Departments, and that it be published in the Supplement to the *Gazette of India*.

Madras.	Burma.
Bombay.	Central Provinces.
Bengal.	Assam.
United Provinces of Agra and Oudh.	Coorg.
Punjab.	Berar.
	N.-W. Frontier Province.

[True extract.]

J. O. MILLER,

Offg. Secretary to the Government of India.

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